MODERN PLASTICS

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MARCH 1943

modern plastics

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GENERAL INTEREST

PLASTICS ENGINEERING

TECHNICAL SECTION

NEWS AND FEATURES

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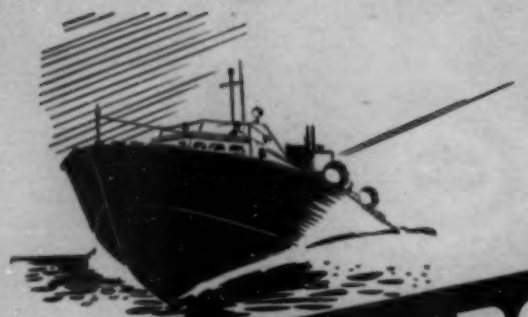
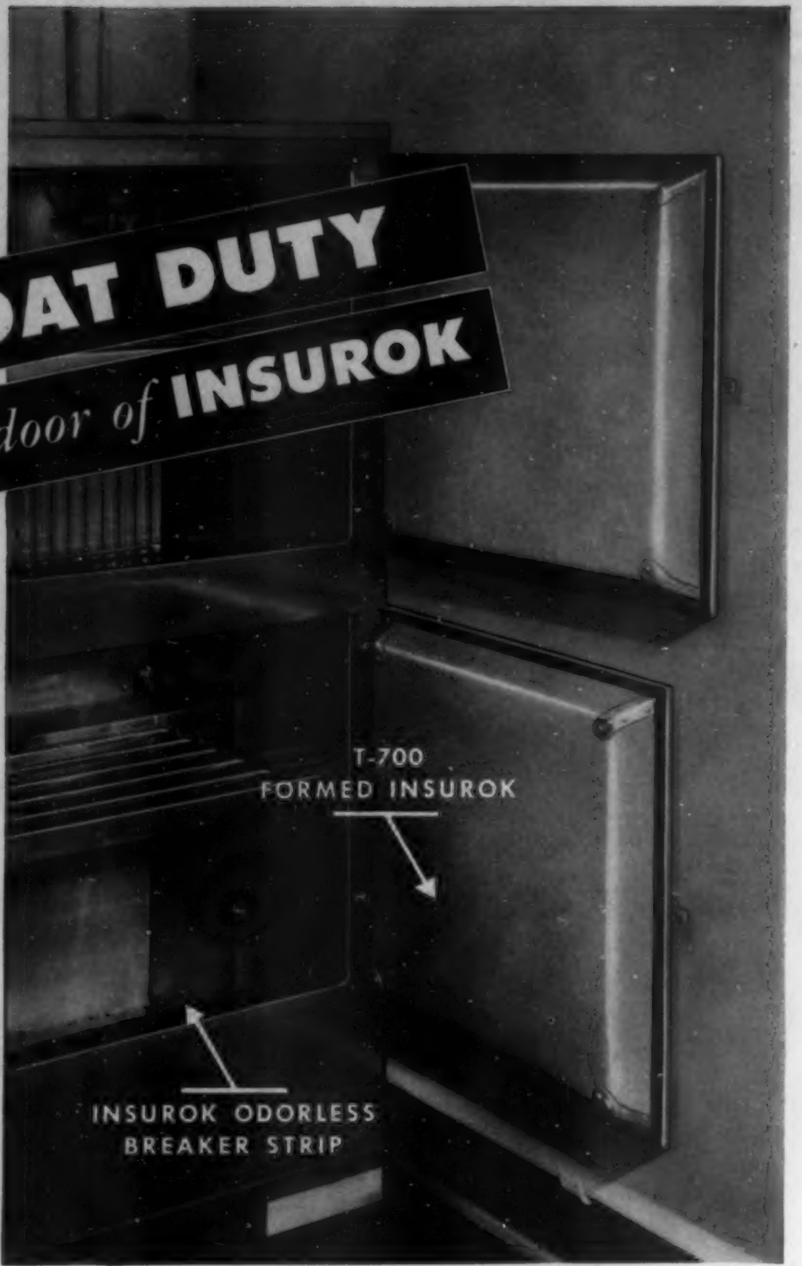


ON P-T BOAT DUTY

—Refrigerator inner-door of INSUROK



It's a tough assignment—P-T Boat duty —and one that takes special qualifications.

But that's just why *FORMED* INSUROK, a thermosetting, fabric type sheet material, can do the job. In spite of its light weight, it has high impact strength to withstand the beatings which heavy seas give both ship and crew. And, for its station inside the refrigerator, as inner-door liners, INSUROK *T-700* has the additional qualifications of low heat conductivity; resistance to corrosion, chemical action of foodstuffs, common cleaning compounds—and does not support fungus growth.

Laminated INSUROK *T-700* is particularly well adapted to war product production because it can be formed without requiring complicated, costly dies—can easily meet size and shape variations, revised specifications, small run requirements.

This or one of the many other grades of laminated or molded INSUROK may be the means of solving some of your war production problems—or may fit into your post-war plans. Richardson Plasticians will be glad to help you determine which grade can best meet your requirements.

The Richardson Company, Melrose Park Ill.; Lockland, Ohio; New Brunswick, N. J.; Indianapolis, Ind. Sales Offices: 75 West St., New York City; G. M. Building, Detroit, Mich.

INSUROK

MADE AND SOLD ONLY BY THE RICHARDSON COMPANY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THE MATERIAL
INNER TEETH OF RING ENGAGE TEETH OF COLLAR. OUTER TEETH BROACH INTO MATERIAL and lock stud
THE ROSÁN LOCKED-IN STUD
FOR PLASTICS AND SOFT MATERIALS
PATENTS PENDING
The Rosán Locked-In Stud is the final solution to the problem of installing a stud in plastics permanently. Any amount of force may be applied to a frozen nut without disturbing it. No replacements with oversize studs are necessary, since the stud never backs. These studs do not require shielding at the base because they can be installed from one side in blind holes. The terminal type of stud has a special, removable flanged ring for quick removal of damaged studs. All threads are standard throughout. Special threads upon request.
The Rosán Threaded Insert shown below operates on the same principle as the stud; a permanent installation by the Rosán Locking System.
Manufacturers and engineers are invited to submit their problems to our Engineering Department.
BARDWELL & McALISTER, INC.
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7634 Santa Monica Blvd., Hollywood, Calif.
THE ROSÁN LOCKING SYSTEM
(1) Material has been drilled and tapped. Insert, minus locking ring, has been partly screwed into place.
(2) Insert in place. Top flush with surface of material. Note the counter-bored channel for the locking ring.
(3) Insert locked in place. Inner serrations engaged with teeth of collar. Outer serrations broached permanently into material.

Aero-Quality Lumarith

INTERCEPTS THE "BURN" OF THE INVISIBLE U. V. RAYS

WINGING through the rarefied atmosphere of high altitudes on long flights, our men of the air can suffer severe sunburn induced by the invisible Ultra-Violet Rays. The risk is removed when aviators are protected by cockpit and turret enclosures of Aero-Quality Lumarith, the transparent plastic specially processed to absorb the "burning" rays.... Lumarith plastics are known for their great versatility. As a case in point, while Aero-Quality Lumarith screens out the severe sunburning Ultra-Violet Rays, regular Lumarith transmits up to 80% of these rays for such applications as hospitals, animal husbandry and agriculture.

CELANESE CELLULOID CORPORATION

The First Name in Plastics

Celanese Celluloid Corporation, 180 Madison Ave., New York City, a division of Celanese Corporation of America Sole Producer of Celluloid* (cellulose nitrate plastics, film base and dopes) . . . Lumarith* (cellulose acetate plastics, film base, insulating, laminating and transparent packaging material and dopes) . . . Lumarith* E. C. (ethyl cellulose molding materials) . . . *Trademarks Reg. U. S. Pat. Off. Representatives: Cleveland, Dayton, Chicago, St. Louis, Detroit, San Francisco, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto, Ottawa.

A DIVISION OF CELANESE CORPORATION OF AMERICA

Could be—

Plastics Helicopter Predicted for Every Garage

BALTIMORE, Md., Jan. 22 (AP) —Can you imagine backing your plastic helicopter out of the garage some Sunday morning, taking your family for a spin above the countryside, and then, on your way home, stopping at a "roadside" stand to eat hot dogs?

It sounds like a dream, especially now, when the family jalopy stays in the garage most of the time.

However, William Z. Safka, design engineer on plastics of the Glenn L. Martin aircraft company and instructor at the Plastics Industries' Technical Institute, predicts that "someday a plastic helicopter will be in every garage."

After the war, of course.

Here's his idea of the "family plane" of the postwar era:

This "airmobile" will be constructed largely of plastic materials one fifth as heavy as the materials used in present-day passenger planes, but will have a tensile strength greater than steel.

You will be able to order your helicopter in any color and shade your wife selects, and it will be fade-, rust- and dent-proof.

It will cost about $1,200 and fly for six miles on a gallon of gasoline.

It will be more maneuverable than present-day automobiles.

It will contain safety devices making it practically foolproof.

The size of an automobile, the helicopter will be able to park in any space an automobile can back into.

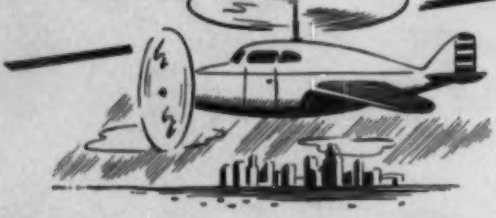
If Mr. Safka's prediction comes true, the old melody "Come Josephine in My Flying Machine" may become the theme song of the postwar generation.

Continued on Page 4, Column 7

Continued on Page 4, Column 6

from Christian Science MONITOR — Jan. 22, 1943

"PLASTICS— The Magic Industry with a Majestic Future"



The amazing accomplishments with plastics to date have already earned it the title of "The magic industry with a majestic future." As is boldly suggested by the newspaper article reprinted above, the continued skillful application of these new materials could easily revolutionize the aircraft—as well as other industries.

Many firms are now "tooled up" for plastics, and only the lack of technical knowledge can hold back the full scale use of plastic materials. It is for those who see today's opportunities with plastics and who also have an eye to the future . . . and for those men who need *more* knowledge of plastics for the benefit of their present production programs, that the Plastics Institute offers an unusual Home Study plan. During spare hours, a wealth of valuable information is available through this course, covering the same fundamental subjects that are given at the Institute in the Plastics Engineering Course.

Step-by-step you are taught to know the basic materials and their properties and limitations, how to develop dies for injection molding, how to fabricate wood, glass and fabric impregnated materials, etc., etc. You secure training that has already qualified scores of Plastics Institute graduates to *competently* enter the industry.

Full details on the 44 illustrated lesson assignments will be sent on request — as well as a copy of the booklet "World of Plastics." Write for yours today.

Study-Forums are also conducted by the Institute in many leading cities; and a twelve-months resident Plastics Engineering Course is available at the Institute's extensive facilities in Los Angeles.

Plastics INDUSTRIES TECHNICAL INSTITUTE

NEW YORK 1220-A Chanin Bldg. **LOS ANGELES** 182 S. Alvarado St. **CHICAGO** 626-A LaSalle-Wacker Bldg.

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Plexiglas . . . protector of America's production soldiers

This worker in North American Aviation's Texas plant wears a transparent, light-weight Plexiglas *face shield. Through the use of such devices, eye injuries in the plant were reduced by one-half in five months.*

Light-weight, permanently transparent, shatterproof Plexiglas safety shields are comfortable to wear and handy to use. Women as well as men wear largest size Plexiglas protectors without tiring.

At all times these crystal-clear acrylic plastic shields provide users with an unhampered view of their hands and work.

Due to many direct military applications, the amount of Plexiglas which can be supplied for safety shields today is limited. After the war, however, these ideal safety devices will be available to American industry.

• • •

Rohm & Haas Company, Washington Square, Philadelphia, Pa.; 8990 Atlantic Blvd., South Gate, Los Angeles, Calif.; 619 Fisher Bldg., Detroit, Mich.; 930 No. Halsted St., Chicago, Ill. Canadian Distributor — *Hobbs-Glass Ltd., Montreal, Canada.*

THE CRYSTAL-CLEAR ACRYLIC PLASTICS

PLEXIGLAS

SHEETS AND RODS

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PLEXIGLAS *and* CRYSTALITE *are the trade-marks, Reg. U. S. Pat. Off., for the acrylic resin thermoplastics manufactured by the Rohm & Haas Company.*

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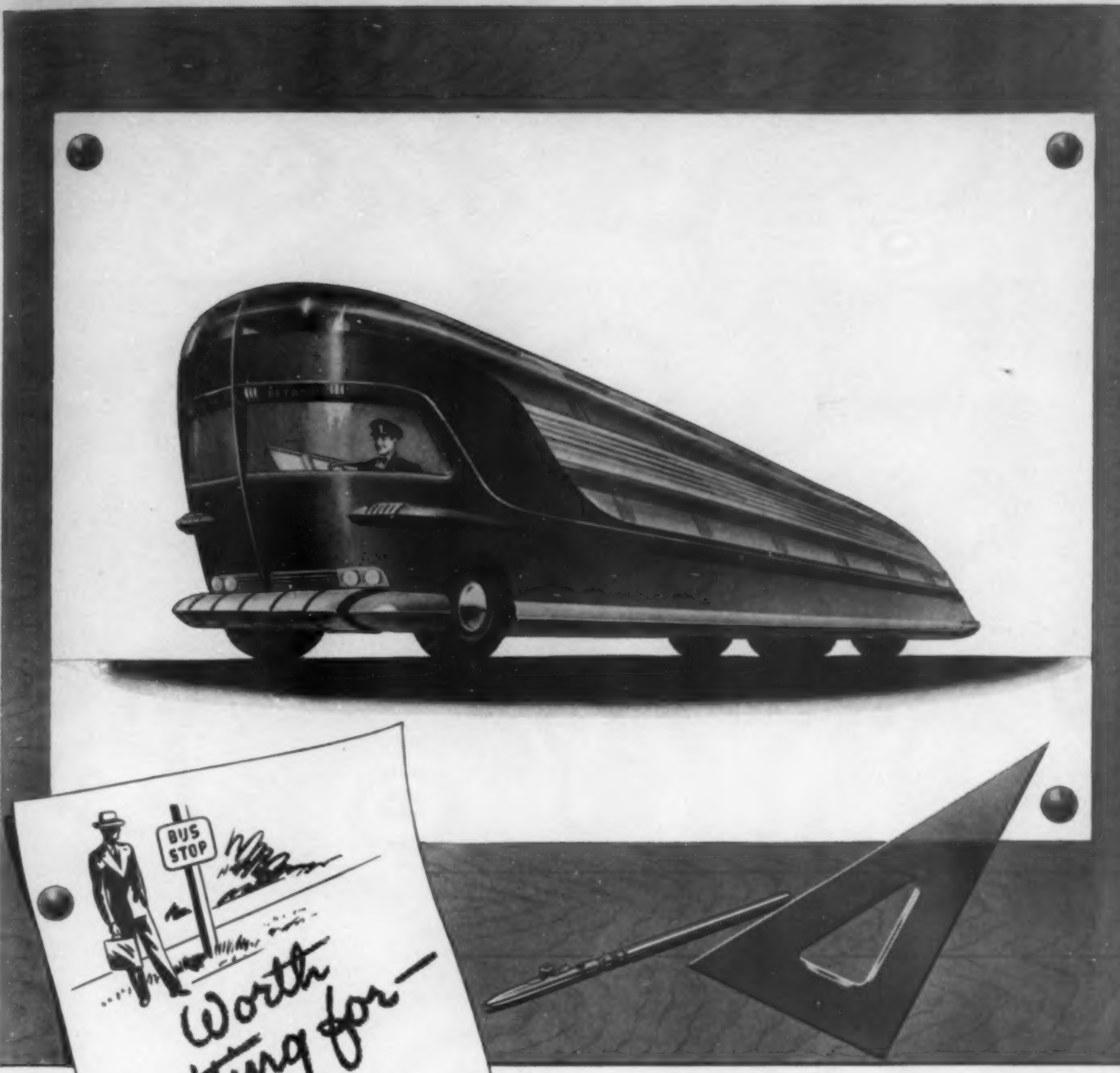
Manufacturers of Chemicals including Plastics . . . Synthetic Insecticides . . . Fungicides . . . Enzymes . . . Chemicals for the Leather, Textile and other Industries



AND worth sacrificing for, too—this super-bus of the future that's a'building in the minds of men with vision. For cheap, swift, comfortable bus travel, to school, to the office, to the airport, or across the country, is part of the new post-war America we all hope, work and fight for.

Have a look at the double decker conjured up by designers Sundberg and Ferar. Then think of how much plastics will help to make this dream come true: plastic upholstery, plastic window shades, plastic light fixtures, hardware, decorative accessories. And hidden from view in the power plant, air conditioning system, control equipment, will be hundreds of plastic parts to help make the wheels go round.

When you think of plastic moldings for post-war products we suggest you consult the Kurz-Kasch "Plastic Round Table"—a group of specialists in design, materials, tool-up and molding. Kurz-Kasch can give you complete service under one roof, one responsibility.

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Planners and Molders for the Age of Plastics

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Southwark

00-ton semi-automatic presses for accumulator operation

3,000-ton self-contained die-hobbing press

9,500

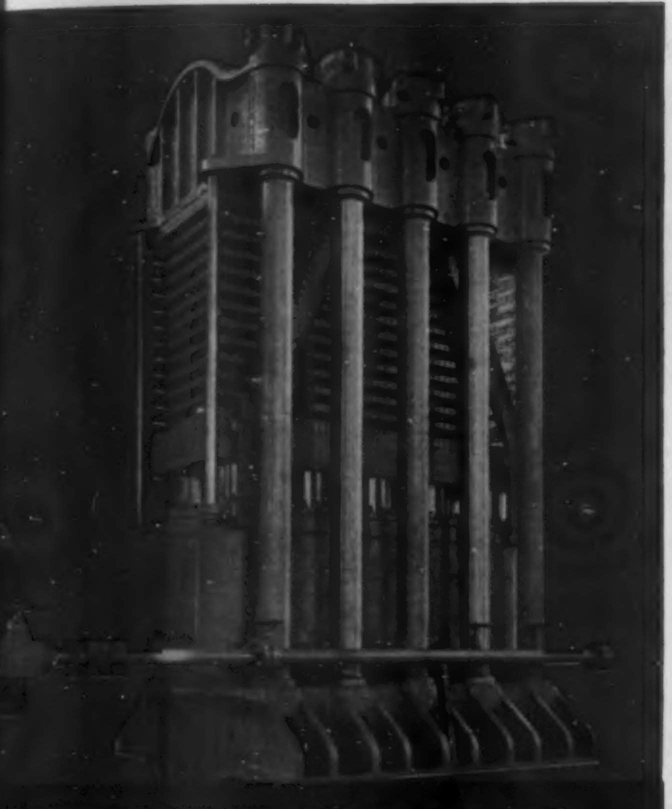
150-ton self-contained semi-automatic molding press

Hydro-pneumatic accumulator system

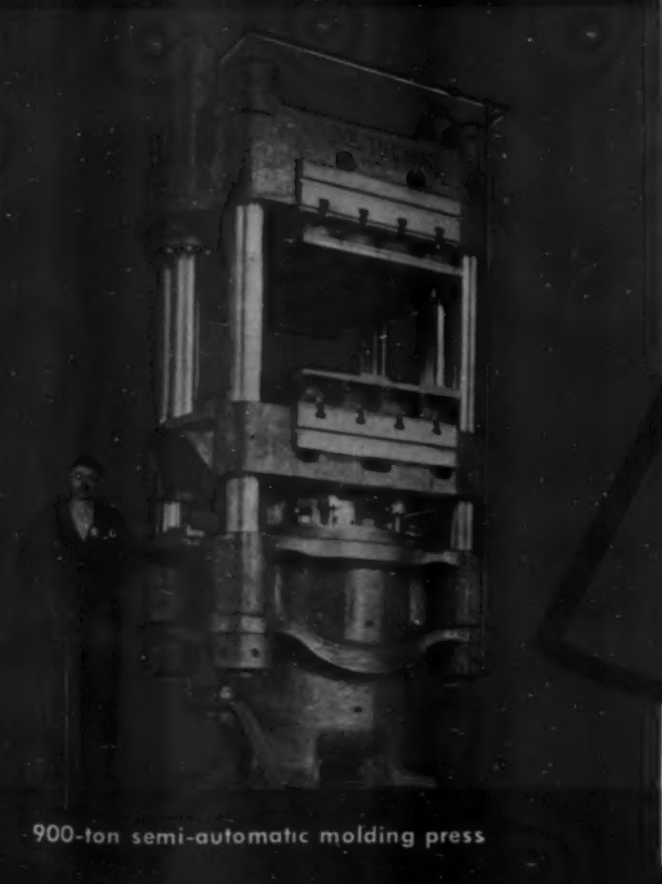
900

WAR INDUSTRIES

Hydraulic Presses



9,500-ton multiple-opening steam platen press



900-ton semi-automatic molding press

Sound design, good materials and honest workmanship are part of every Southwark press. Southwark's years of press building experience are paying real dividends to the leaders in the plastics industry now that uninterrupted production is all-important and replacement parts are at a premium.

Southwark builds a comprehensive line of modern plastics presses. Whatever your molding problem, consult with Southwark engineers. They can help you do a better job—more economically.

Baldwin Southwark

Baldwin Southwark Division,
The Baldwin Locomotive Works, Philadelphia; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco.

CAN SHORTCUT MANPOWER PROBLEMS

No need to rob the cradle or the old men's home to replenish your personnel if a portion of your production can be converted to molded plastics.

Plastics can replace strategic materials such as rubber, cork, tin and aluminum. They can be adapted to do individual jobs better than other materials.

Plastics have other virtues: they can be molded around metal parts or pieces, both small and large, thus eliminating much later hand assembly; they can be formed in less time than other materials, and on our equipment. You, as our customer, would have our facilities working for you to produce the parts or pieces you need.

STERLING PLASTICS CO.

UNION, NEW JERSEY

Some of Our Future Customers are Using NIXON PLASTICS Now

On every fighting front...on land and sea and in the air...Nixon Plastics are replacing critical materials...not only replacing them but resulting in improving the product in many cases. When the war is over, millions of American fighting men will return with a first hand knowledge of plastics gained from using them in war. They will not consider plastics as a substitute but as something better...lighter...more flexible...stronger...more resistant than the materials they displaced. The resources of our company which are now devoted to producing war and essential civilian products will be available to them and to you as users of Nixon Plastics.

NIXON *Plastics*

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MATERIALS: Cellulose Acetate • Cellulose Nitrate • Ethyl Cellulose

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We ain't dead...just busy

We may have been unduly quiet . . . . but reports of our death have been greatly exaggerated.

Quite a few million people have dropped out of civilian life to give personal attention to the unholy three.

A lot of businesses have had to do the same to keep our boys supplied, equipped and armed. No question where all of us owe our first loyalty.

But, we're running ads like this (got any better suggestions?) to keep you remembering that we were great guys when we had it, that we had a way with those molding powders.

Matter of fact, we've learned a lot of new tricks working for our Uncle. We've molded things that seemed impossible, because you can't say "no" to 6 million guys named Joe who are out there saving your neck.

We're storing up all this experience for the jobs that you are going to have for us when we go back to the good old days of worrying about how to sell more goods. Please file the name. We'll be glad to send you a file.

"A Ready Reference for Plastics" written for the layman, is now in a new edition. If you are a user or a potential user of molded plastics, write us on your letterhead for a copy of this plain non-technical explanation of their uses and characteristics. Free to business firms and government services.

ARMY E NAVY

BOONTON MOLDING COMPANY

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With Their Help We'll Win

These women, machining precision parts on South Bend Lathes in a vital war plant, are typical of thousands of women who are doing their part to win the battle of production.

With eager hearts and nimble fingers, thousands of American women are working shoulder to shoulder with men in vital war industries — replacing those who have left their machines to defend their country. And they are doing a fine job of filling men's shoes, for they know that the battle of production must be won to keep their men at the front supplied with the guns, planes, tanks, bullets, and thousands of other things an army must have to be victorious.

Women learn to operate South Bend Lathes in a surprisingly short time. Not that just any girl can become an expert machinist or toolmaker over night. But on certain classes of work—the kind of work you would expect a beginner to do—women are highly successful.

Quick to appreciate quality, women like South Bend Lathes. They like the fully enclosed design with no exposed pulleys, belts, or gears—the smooth operation of conveniently placed controls—the absence of rough edges and sharp corners that might catch their clothing—the dependable precision that enables them to turn out maximum production, even when extremely close tolerances are specified. And, most of all, they appreciate the ease of operation which reduces fatigue to a minimum and seemingly shortens the work-day by hours.

South Bend Engine Lathes and Toolroom Lathes are made in four sizes, 9" to 16" swings. South Bend Turret Lathes are available in three sizes. Write for information, specifying size and type of lathe in which you are interested.

"HOW TO RUN A LATHE"
A valuable handbook for apprentice training. Explains the operation and care of engine lathes. 128 pages—365 illustrations. Sent postpaid for a 25c War Stamp.

ARMY E NAVY

SOUTH BEND LATHE WORKS
SOUTH BEND, INDIANA — LATHE BUILDERS FOR 36 YEARS

HELP... *for the asking*

OUR ABRASIVE ENGINEERS have done much to speed up, improve and reduce costs on finishing and polishing operations. That is how they can help you.

These men are *abrasive specialists.* They know the advantages of one abrasive mineral compared with others, the grit sizes, types of coating, kinds of backing and the many hundred forms and sizes in which we fabricate these basic materials for sanding operations—old and new.

In the field, they are constantly in touch with developments in the industry. New, ingenious methods of applying our products are being developed almost daily, and these men of ours are following those developments. That is their qualification for counseling you on faster, better, more economical production.

The hard-earned knowledge and experience of trained Behr-Manning Abrasive Engineers is yours for the asking. Just phone or write our nearest branch and we'll have a capable man see you promptly.

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(DIVISION OF NORTON COMPANY)
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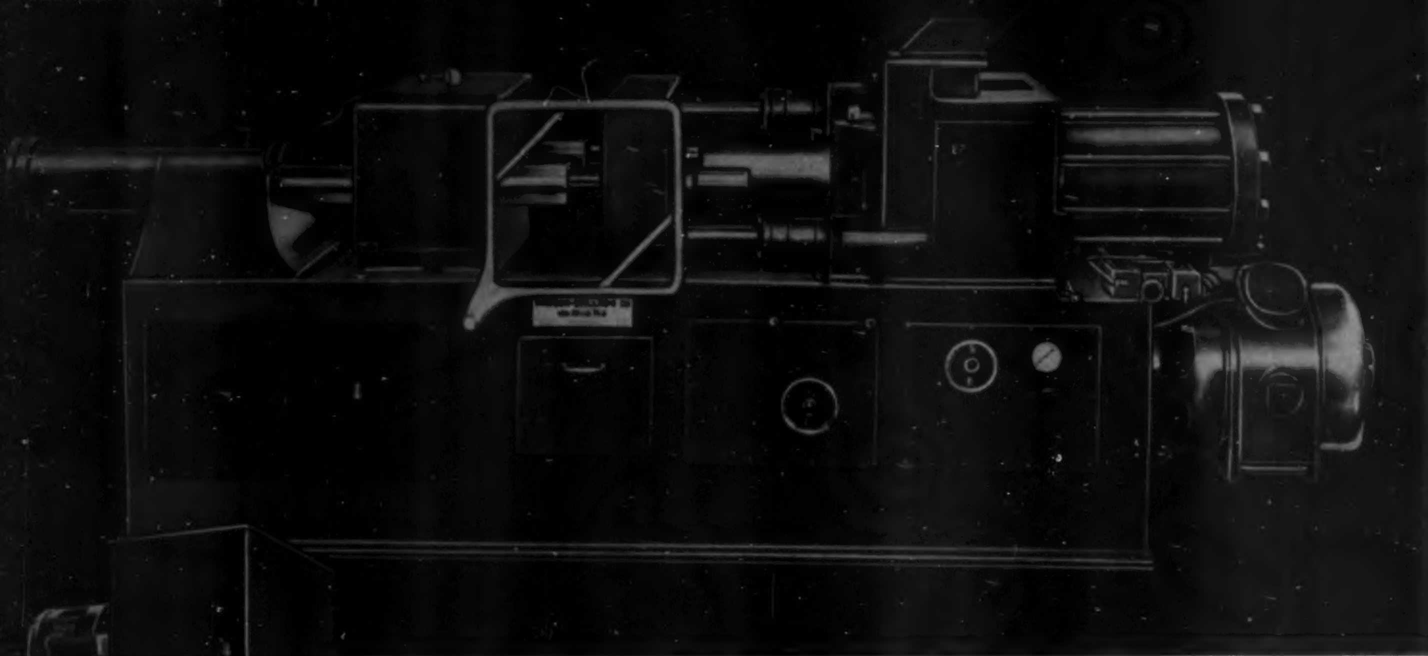
W-S INJECTION MOLDING MACHINE

Available in 6, 8, 12 and 16 oz. capacities. Equipped with Zoning Control Heating Cylinder, Positive Clamping Mechanism, Adaptor-Type Nozzle.



Some Day Victory Will Bring the *Cease-Firing* order

—*But* IT NEEDN'T MEAN *Cease Producing* FOR YOU

Molders of war-needed plastics can change over quickly to meet post-victory production needs—with Watson-Stillman Injection Molding Machines and Hydraulic Presses. This equipment can be adapted to new uses by the mere substitution of a new die.

W-S Injection Molding Machines offer precise temperature control, more rapid color change and less waste material, at the same time minimizing the possibility of flash. W-S Compression Molding Machines—of semi-automatic or full automatic types—make routine work of formerly difficult castings—in some cases using both vertical and horizontal rams in the same job.

Call in Watson-Stillman engineers for consultation and you'll benefit by the advice of an organization familiar with the plastic industry since its very beginnings, and seeking in its research and plans to help keep plastic molders in the vanguard of new and improved techniques. The Watson-Stillman Company, Roselle, N. J.

W-S FULLY AUTOMATIC COMPRESSION MOLDING MACHINES

Available in 25 ton, 50 ton and 75 ton types. Larger die space. Faster Operation. Centralized Control. Positive Action Safety Devices. Rapid Mold Changes.

TO HASTEN VICTORY

Buy U.S. WAR BONDS

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Engineers and Manufacturers of Hydraulic Machinery and Equipment—Hydraulic Presses, Pumps and Jacks, Forged Steel Valves and Fittings

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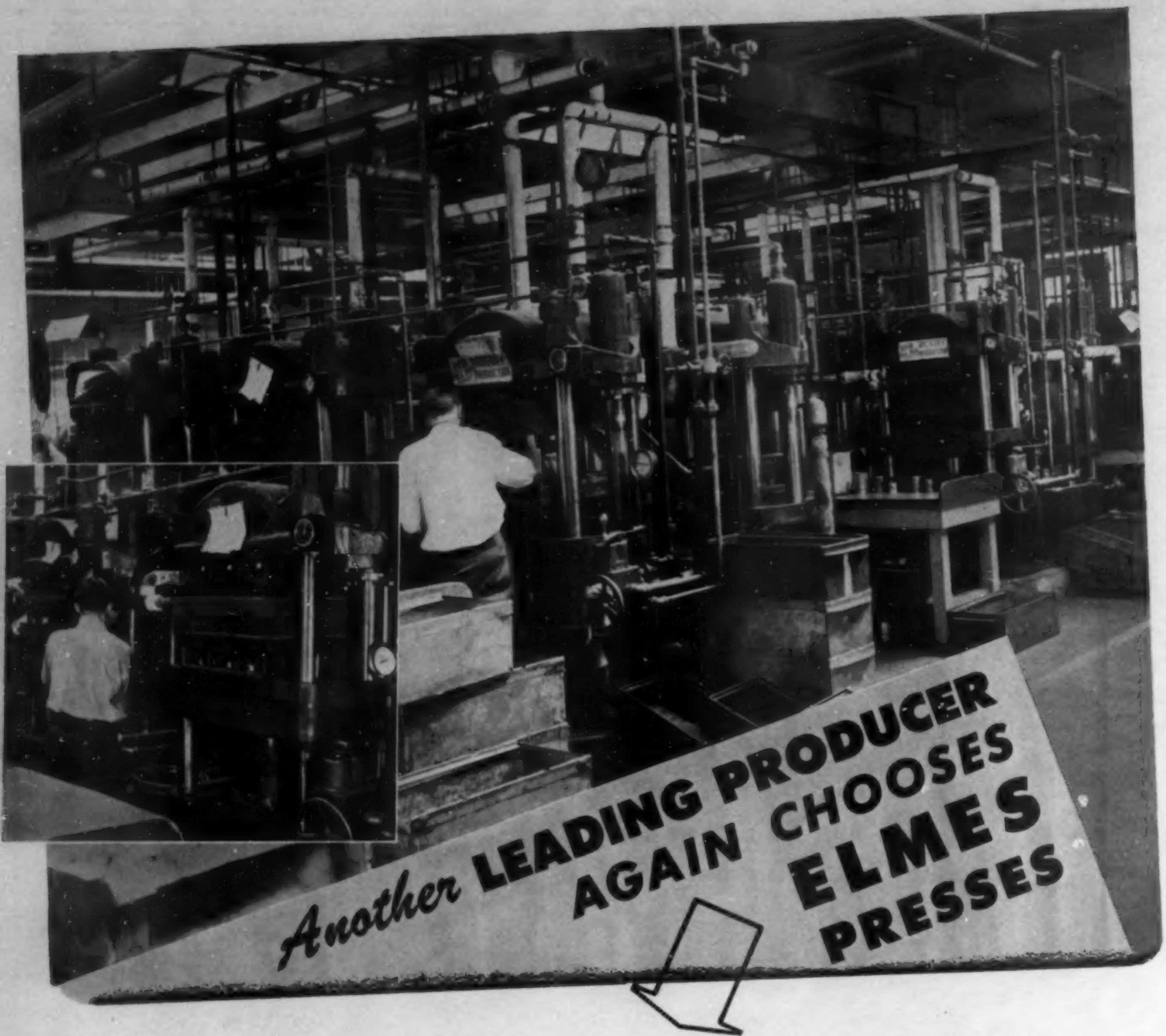

. . . to make quality molded products faster. This installation of Elmes Hydraulic Presses began in a small way; repeat orders have expanded it into this large battery.

This example is typical of many manufacturers who have regularly reordered Elmes Presses, based on performance. The success of Elmes Presses is due to: (1) Long Experience (2) Proper design (3) Precision manufacturing (4) Rigid inspection and (5) Conscientious service to customers. Elmes builds metal working presses, plastic molding presses, extrusion presses, pumps, accumulators, valves and accessories.

Elmes engineers will cheerfully study your hydraulic power problems and make suggestions. Why not write them today?

Elmes SINCE 1851

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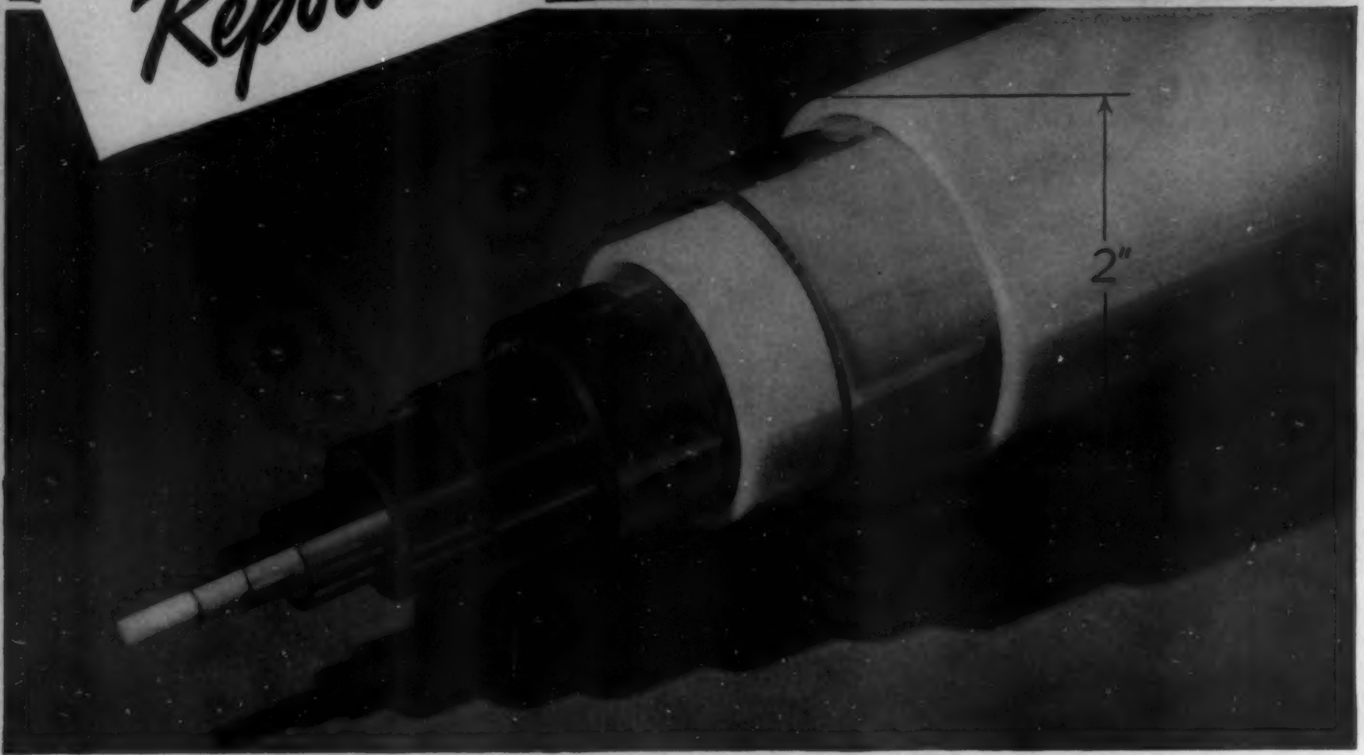
METAL WORKING PRESSES • PLASTIC MOULDING PRESSES • EXTRUSION PRESSES • PUMPS • ACCUMULATORS • VALVES • ACCESSORIES

Progress Report

EXTRUDED PLASTICS
INCORPORATED

NEW CANAAN AVENUE
NORWALK, CONN.



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PLASTIC TUBING
made from Tenite II

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TULOX HR REG. U.S. PAT. OFF.

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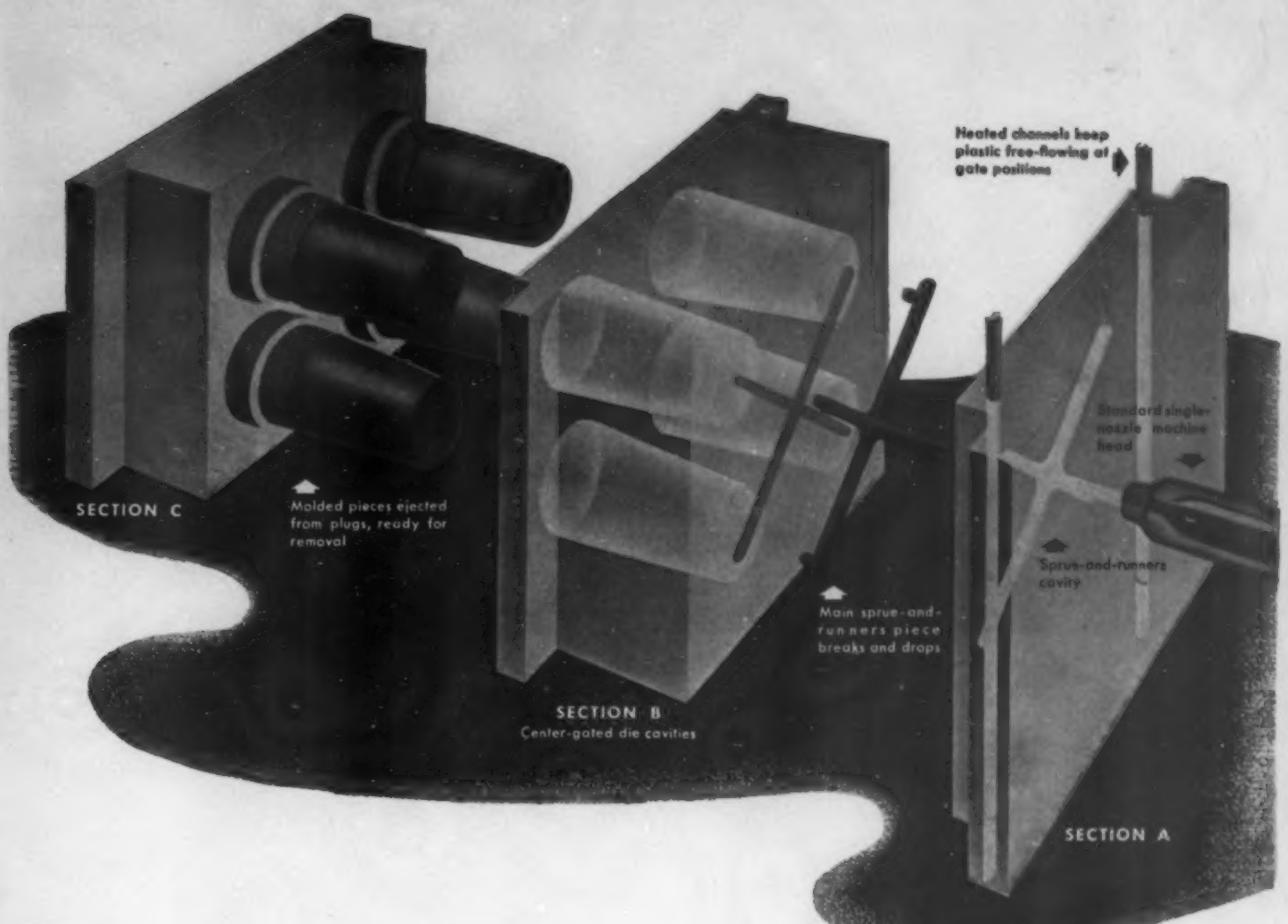

How to mold better pieces at less cost

Du Pont multiple-cavity molding technique eliminates weld lines and costly multiple-nozzle machine head

THIS three-dimensional diagram shows Du Pont-developed multiple-cavity mold in its open position, releasing four drinking tumblers simultaneously. Many different articles can be produced by this method. The number of die cavities is limited only by the capacity of the machine.

OPERATION. In closed position, Sections A, B and C are a single unit. After injection of plastic, A and B separate, freeing main sprue from the nozzle. Next, C and B separate, breaking secondary sprues to each individual tumbler, thus freeing main sprue and runners, which drop into receiving pan. Final movement of C from B causes ejectors to loosen molded tumblers on plugs ready for removal.

Points of Improvement on Usual Molding Method

1. Center gating, at right angles to the piece, provides even flow of plastic throughout the mold, thus eliminating weld lines.
2. In contrast to the cost of a multiple-nozzle machine head and die, retention of the standard single-nozzle and construction of a multiple-cavity center-gated die are quite economical.
3. Unlike multiple-nozzle heads, the standard single-nozzle machine head needs only infrequent, inexpensive care to insure efficient operation.
4. Finishing the molded pieces is a quick operation. It consists merely of trimming the secondary sprues, or gates, and then buffing to smooth finish.

This development of multiple-cavity molding technique is but one of many industrial achievements of Du Pont Technicians. For more information on the methods or mechanics of the process explained here, or for assistance on the best use of Du Pont plastics on priority, write: E. I. du Pont de Nemours & Company (Inc.), Plastics Department, Arlington, N. J.

DU PONT
REG. U. S. PAT. OFF.

"LUCITE" · "PLASTACELE"

methyl methacrylate resin — **cellulose acetate plastic**

"STRIPPING" IS AN ART!

Ask any burlesque habitue! — Or, better still, ask any Industrial Hard Chromium customer!

Plated molds that have been in use for a considerable time may be "stripped" and replated with Hard Chromium . . . thus continually renewing their life. The process requires skill and care to avoid damaging the mold itself and to preserve its original dimensions.

Perhaps the best evidence of how well we do our job is the fact that our customers entrust us with so many priceless molds with full confidence in the care we give them.

Industrial Hard Chromium Plating is helping to conserve vital metals and manhours for our war industries. If your production involves molds or metal parts in motion that should be protected against abrasive wear or corrosion, our engineers will be glad to analyze your problem and make expert recommendations for its solution.

INDUSTRIAL HARD CHROMIUM Co.

"Armorplate for Industry"

15 ROME STREET • NEWARK, NEW JERSEY

OUR DARKEST SECRETS shed the most light

Censorship draws a tight curtain over our night and day war production. Back of this curtain, our injection moulding facilities for the handling of your problem or your product grow brighter than ever.

These facilities are three fold:

A capacity to produce in large volume with utmost accuracy on fast schedules,

A closely knit group of designing and engineering technicians,

And capable, experienced die-making and finishing personnel.

The connection between these facilities and your production of a part may be closer than you think. Whether your problem is current or future, talk to us first about custom injection moulding.

For Custom Injection Moulding .... try the Trio

Custom Injection Moulders

WORCESTER MOULDED PLASTICS COMPANY

8 GRAFTON ST., WORCESTER, MASS. 17 E. 42nd ST., NEW YORK, N.Y.

LEA

Specialists in Cutting and Buffing Methods and Materials

IN PEACE

No better examples of the results of Lea service in connection with peace time merchandise can be found than in this CATALIN Brush Handle and these CRYSTALITE Cosmetic Containers.

IN WAR

And for plastic war implements with which Lea Technicians have lent a helping hand; Bomber Noses made of PLEXIGLAS are much in the public eye right now.

LEA Technicians, skilled in the art of finishing surfaces of all kinds, have been very helpful to those working with plastics. Today, their service is doubly valuable in helping manufacturers to: (1) effectively meet more rigid specifications; (2) do the work faster; and (3) do it more economically.

Write us about your problem of cutting or buffing or any other step having to do with the finish of your plastic articles. We have the experience and materials with which to help you.

THE LEA MANUFACTURING CO.

Burring, Buffing and Polishing . . . Specialists in the development of Production Methods and Compositions

Waterbury, Conn.

DESIGN IT NOW FOR PLASTICS

Here's Help for You on Post-War Product Planning

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You Get ALL FIVE When You Use

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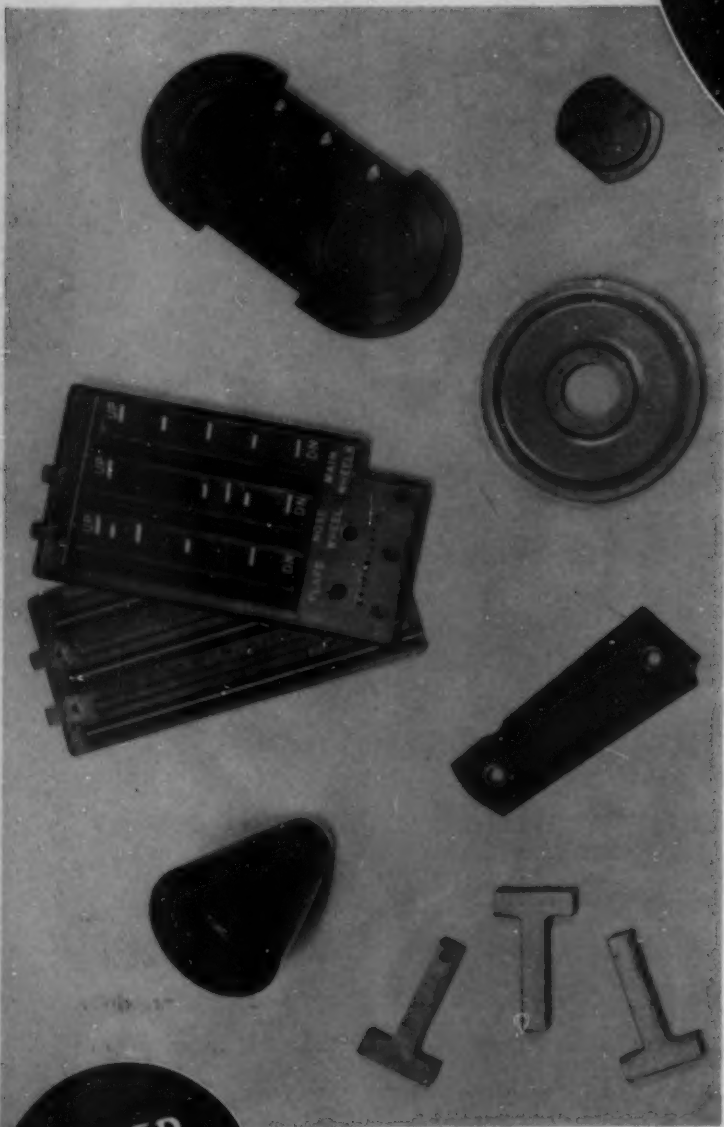
COLUMBIAN CO-RO-LITE

REG. U. S. PATENT OFFICE

Sisal Fillers



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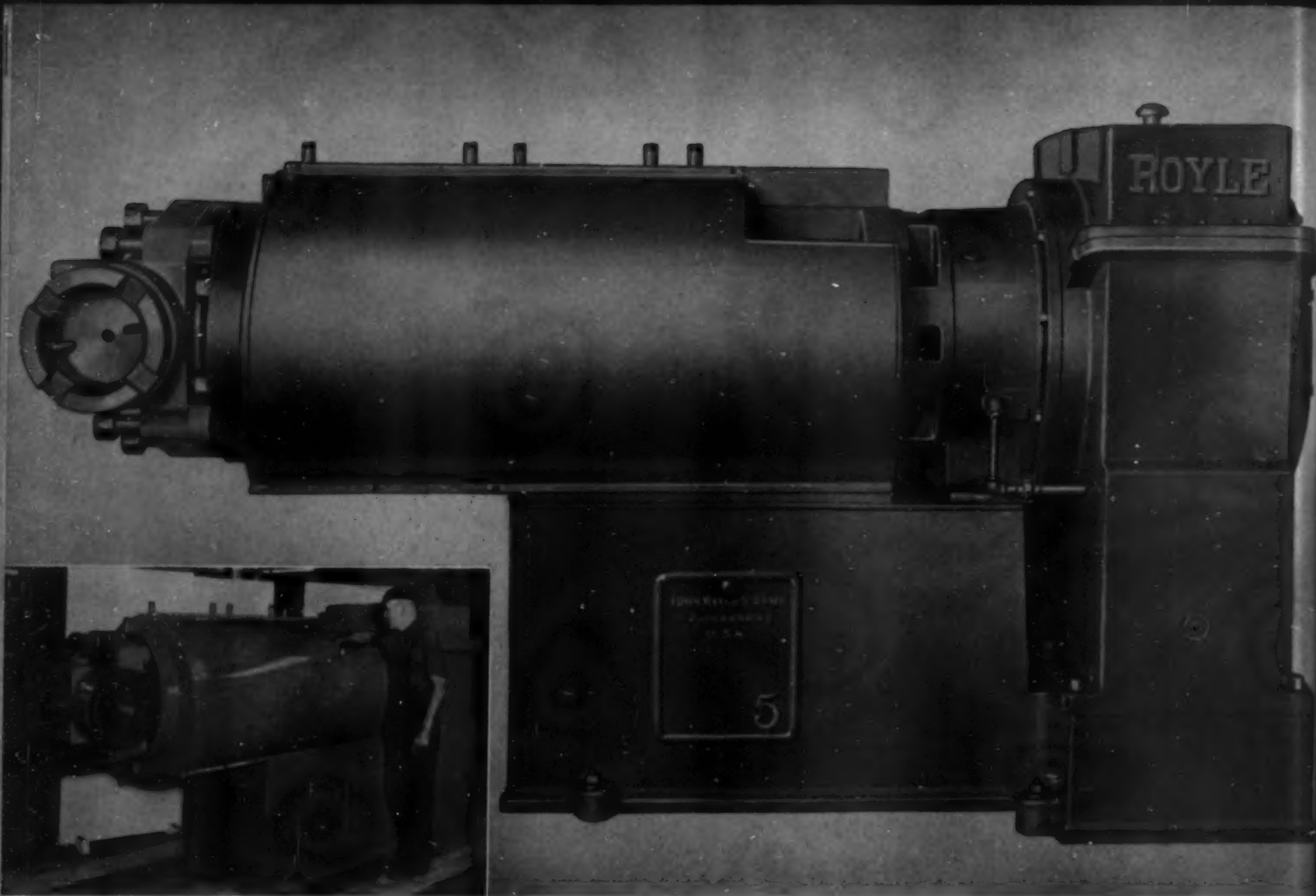
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A combination *Unique* in plastics

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LIGHTWEIGHT. Acetate rides in the "flying dark rooms" of the Air Force. Using a lightweight plastic developing-tray, Army photographers develop their films in flight for study by the bomber command.

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AS ONE OF THE NATION'S leading producers of cellulose derivatives, Hercules has devoted years to producing better cellulose plastics. For information, address your letter to Dept. MP-33.

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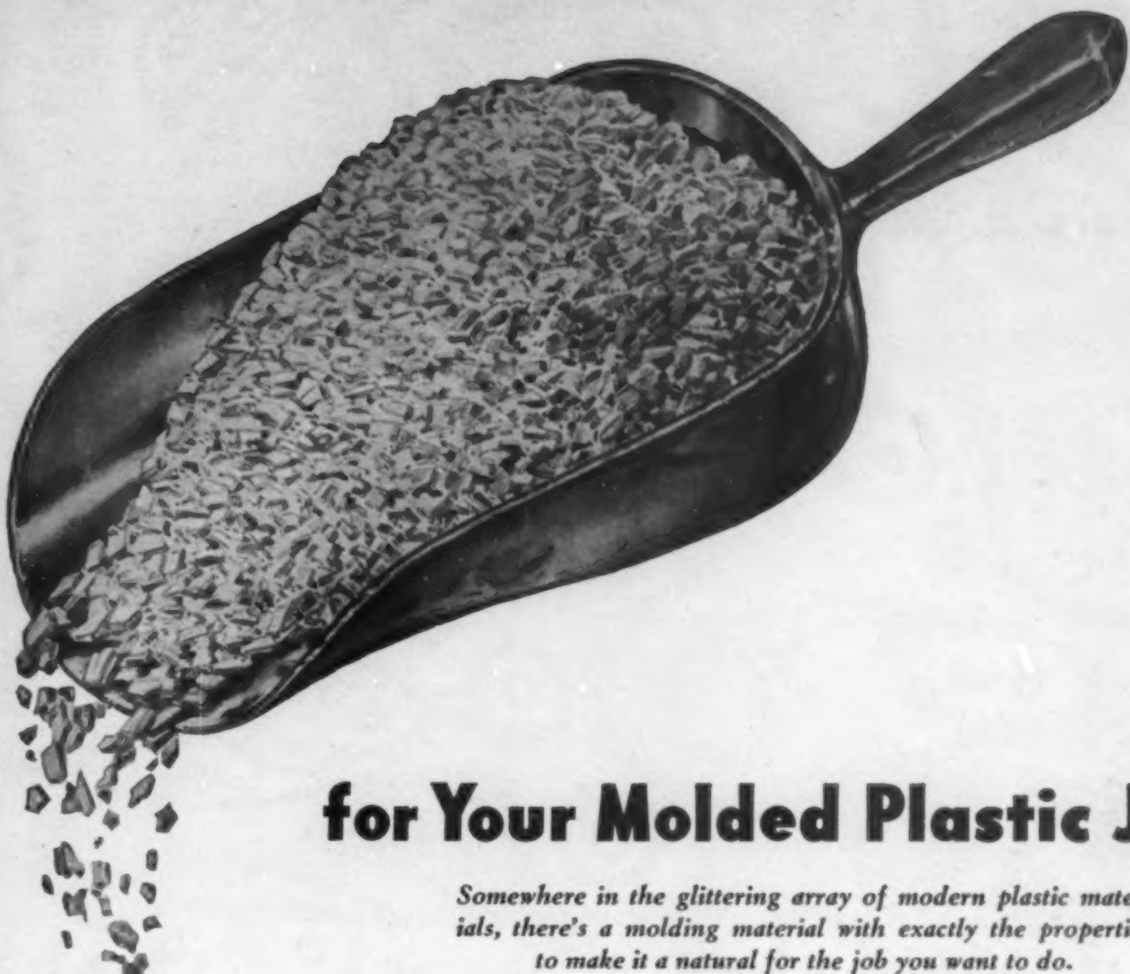
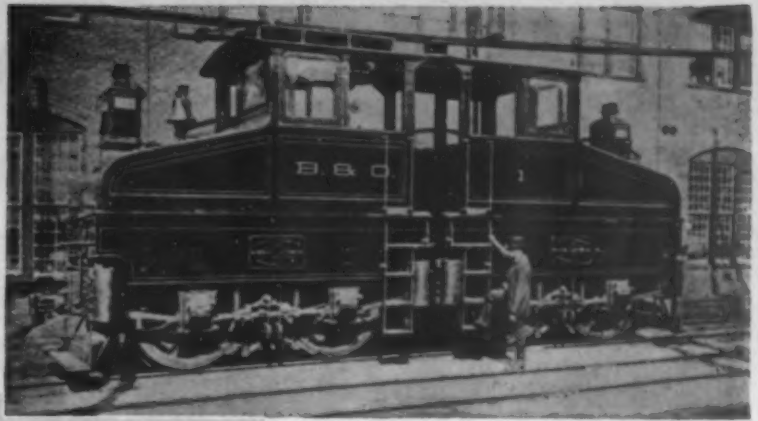
Incorporated

Above Left: A 570 ton Laboratory Press with electrically heated platens, two-pressure pumping unit and adjustable pressure control.

Above Right: An open-side belt press of the precision type, with steam-heated platens.




B & O


4911

Announcing

THE CARVER LAMINATING PRESS . .

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Government departments and war plants are now using laminated identification cards and badges. After photographs and pertinent information are placed on the cards or badges, they are laminated between sheets of cellulose acetate under heat and pressure. The lamination is performed on the new Carver Laminating Press, developed from the well-known Carver Laboratory Press for this purpose. The resulting card or badge cannot be removed without tearing.

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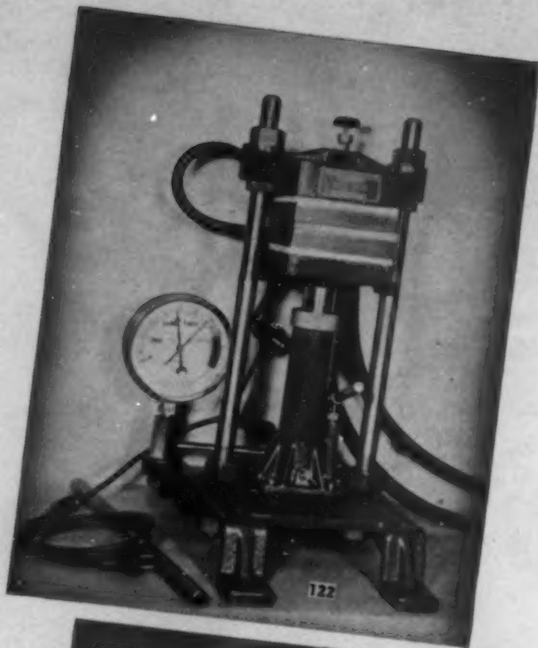
Priorities required under L-159 order of W.P.B. for plastic molding machinery. Write for prices. ***We do not supply cards, badges or plastic materials.***



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AT the inception of the plastic era, manufacturers never dreamed that plastic products would ever be used in the making of war weapons.

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But, when America was thrust into this conflagration, American ingenuity transformed peacetime products into wartime essentials; peace-work into war-work. A grim and paradoxical task. Yet, is not war-work in reality peace work? Don't we attain one through the success of the other? Plastic's part in this great war is of no small importance. Almost every branch of our armed forces is being helped by a product of plastics. And when the war is won, plasties will again go on peace-work —on a larger scale than ever—in more diversified fields — making a greater contribution to the enjoyment of living. We are now planning for that day.

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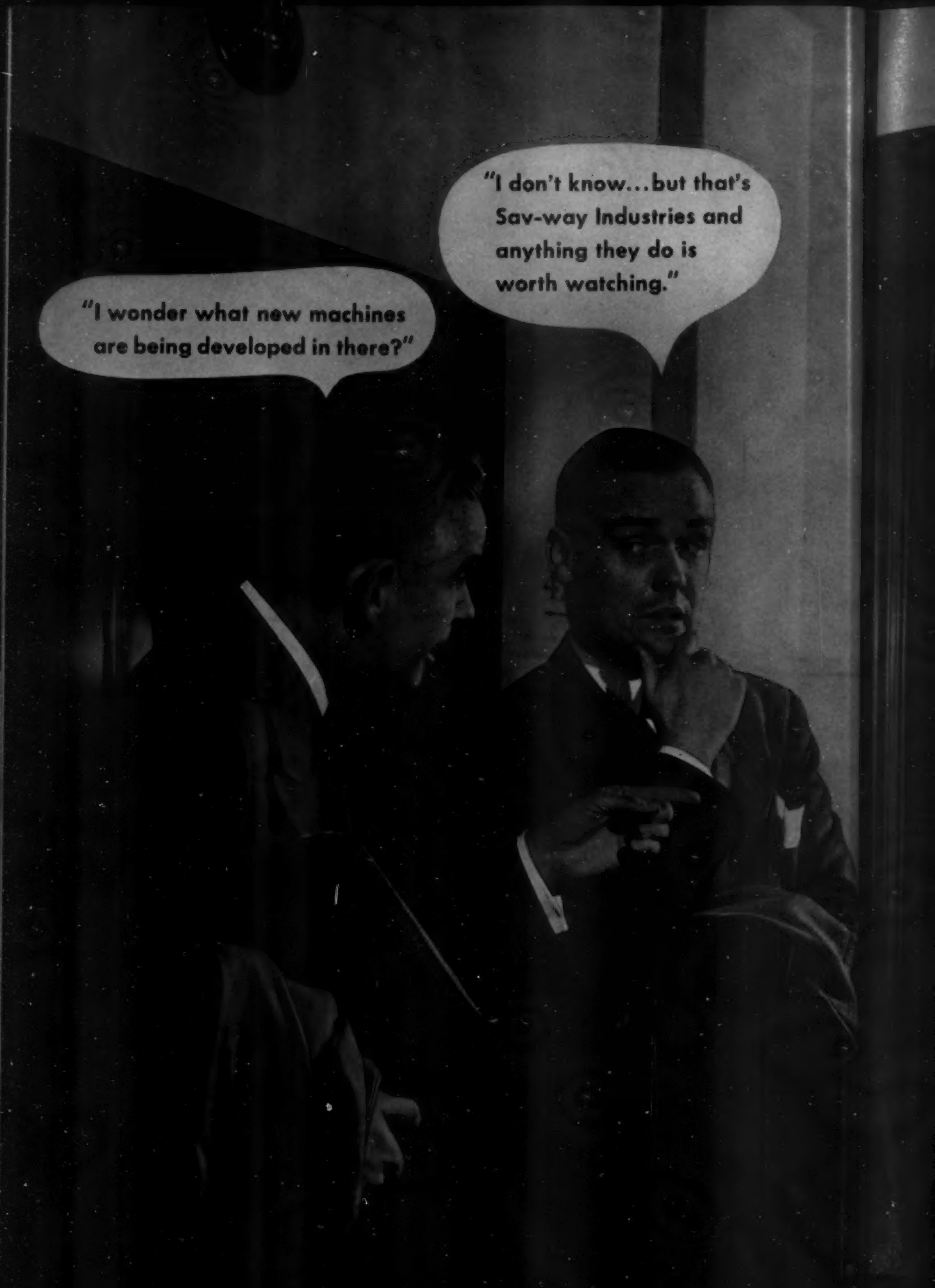
"I wonder what new machines are being developed in there?"
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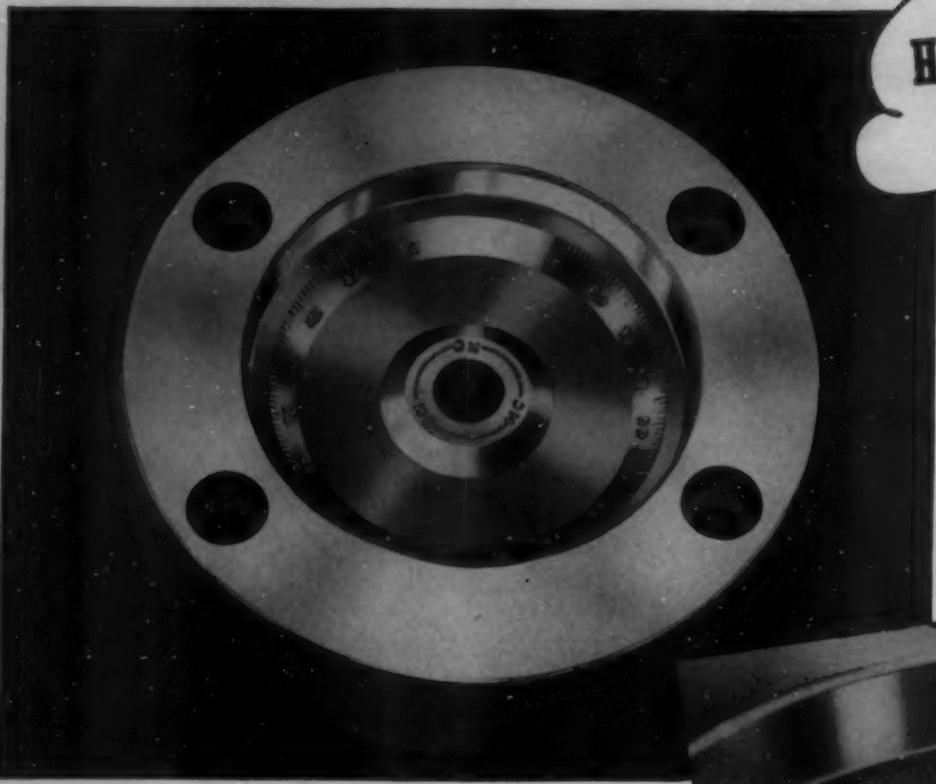

ANGLES

★ ★ ★ There are many angles to every hobbing job. This one has an angle all its own. Yes, a forty-five degree angle, which presents many difficulties, especially as there are lines and figures to be raised on its surface.

But at Midland Die and Engraving Company, difficulties are taken as a challenge. With unsurpassed facilities for plastic molds, die cast dies or hobbing, we welcome the opportunity to demonstrate what skill and meticulous attention to detail can accomplish. No job is too big, no detail too intricate, no tolerances too close for Midland — and prompt deliveries are a "must"!

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MODERN PLASTICS

MARCH 1943 VOLUME 20 NUMBER 7

PHOTO, COURTESY DE HAVILLAND AIRCRAFT OF CANADA, LTD.

The swift and deadly De Havilland Mosquito bomber-fighter, built of resin-bonded plywood, can lick twice its weight in Focke-Wulfs

New war planes for the United Nations

BY the end of 1943, it is expected that the U. S. aircraft industry will lead all others in dollar volume, passing in value of products its nearest competitor, the steel industry, by a wide margin. Last year, deliveries of aircraft had a dollar volume of almost 5 billions, which equals that of the automobile industry in its best years, while current unfilled orders have been estimated at some 20 billions. Since 1940, aircraft factory space has increased from 14,000,000 sq. ft. to more than 70,000,000, and may reach 1,000,000,000 sq. ft. when new facilities are completed.

In time of peace, these figures would not necessarily presage great advances along technological lines. On the contrary, such mushroom growth might conceivably be a deterrant to technical progress rather than its corollary. In haste to capture their share of an expanding market, some manufacturers will inevitably bend their energies to making more of their products and give scant thought to improving them.

In the year 1943, however, growth of the aircraft industry reflects the determination of an angry nation to defeat its foes by using in force the most powerful instrument of modern warfare—the airplane. Because there must be more and more planes, the more leisurely manufacturing methods of peacetime must be revised and stepped up. Because planes must be faster, more sturdily built and more effective in assault than those of the enemy, the soundest and most up-to-date technical and engineering knowledge must be applied to their design and construction. And because old materials are not only growing scarce but have often proved inadequate, newer and better ones must be found.

It is not unusual that plastics and aircraft, new industries both, relatively speaking, should have effected a combination of effort which is producing superior fighting machines. This alliance had been formed before the war began, and has been increasingly strengthened by the accelerated tempo of world events since September of 1939. The warplane of today, therefore, is an ingenious combination of materials, each fitted for its particular function, in which plastics, plywood and high tensile strength papers and other materials impregnated or bonded with plastics are distributed from nose to trim tab.

As a construction element of the fighting plane, plywood is a veteran of World War I. The famed "crates" that reconnoitered over the German lines and fought it out with Richthofen's Flying Circus relied on plywood and fabric glued together with casein and animal albumin. Veneers were glued together in a flat press, and sheets were then wet or steamed and sprung into form. This type of construction had limitations, because the flat-pressed veneers bent to compound curves tended to return to their pressed condition, thus wrinkling and changing shape, and the glues lacked sufficient durability. As a consequence, the new light metals and metal alloys drove the plywood ship from the air.

In the 1930's, with the advent of improved hot press equipment and the commercial availability of thermosetting resin adhesives both in film and in liquid form, the principal objections to wood construction were removed, and the plastic-bonded plywood airplane was put in production.

The new phenolic and urea resin adhesives, proof against mold, fungi, water, oil and gasoline, gave aircraft plywood several advantages over the lighter metals after improved techniques for molding plywood had been developed in response to a demand for more complicated shapes than could be fashioned from flat

sheets. The principle underlying such processes as the Vidal, the Duramold and the Aeromold is that of the application of pressure perpendicular to the tangent of any curved surface by flexible bag methods of molding, with heat supplied by steam, hot water, hot air, or high frequency current. The result of so advantageous a combination of resin adhesives, wood veneers and fluid pressure has been to make aircraft plywood in some respects superior to light metals. Its weight-strength ratio is favorable, and its stiffness outstanding (the *EI*, or stiffness value of aluminum is 22, that of birch plywood 178, of spruce plywood 416) and it can be molded into monocoque shapes of extreme complexity easily and cheaply, whereas metal fabrication would be both difficult and costly. Smooth, streamlined surfaces of plywood structures reduce the wind drag caused by joints, rivets and wrinkles on surfaces of metal. Finally, the availability of material, machinery and labor for plywood construction gives it an advantage in today's market.

The development of paper-base materials for use in military planes is already past the experimental stage, and wing tips of special wood pulp impregnated with phenolic resin are appearing on training planes. Qualities of the material are similar to those of plywood, and it has distinct possibilities as a component of many secondary and some primary aircraft structures.

The development of paper-base materials for use in military planes is already past the experimental stage, and wing tips of special wood pulp impregnated with phenolic resin are appearing on training planes. Qualities of the material are similar to those of plywood, and it has distinct possibilities as a component of many secondary and some primary aircraft structures.

Figure 19, a breakdown of the Curtiss Caravan, shows in detail the structural parts of an airship which are now being constructed of molded or laminated plywood. These include fuselages, wings, elevators, flaps, ailerons, stabilizers, vertical fins, nacelles, bomb doors, floats, controls, rudders, tabs, spars and ribs. Propellers are of high density plywood or laminated lumber, resin glued.

Such structural applications do not exhaust the uses of resin-bonded plywood in the 1943 warplane. It can be molded into ducts, pipes, elbows, tees and wyes for ventilating and supercharging systems. It forms pilot seats that are lighter and more resilient than seats of metal. Cabinets, partitions, doors, flooring and a host of other fittings are of this same versatile material.

A wealth of transparent enclosures characterizes the modern warplane. Nose sections, cockpit enclosures, gun turrets, observation hatches, blisters, windows, tail empennages—any place in the plane where it is necessary for a man to have a clear and unobstructed vision of sky or ground—all are fabricated of acrylic or cellulose acetate sheet. These huge plastic sections are favored not alone for their optical properties but because they possess other qualities which make them eminently serviceable. They weigh less than half as much as glass, yet are strong enough to withstand the wind resistance encountered by planes travelling at from 300 to 400 miles an hour. Sun and severe weathering do not affect them unfavorably, and they have stability and shock resistance. Their extreme ease of forming is a factor in their favor, together with the fact that cracks and bullet holes may easily be repaired in the field.

A fighting plane without its radio is about as effective as a near-sighted infantryman who has lost his glasses. In this all-important unit of combat equipment, the superior strength, impact resistance and electrical properties of plastics have been drawn upon by the designers of modern warships. Antenna masts are of molded-laminated phenolic materials, and stanchions are molded-macerated or injection-molded polystyrene. Loop antenna housings incorporate plasticized cellulose acetate flake and fabric-filled phenolic compounds, and the dehydrators which keep the moisture out of them have housings of molded cellulose acetate. Radio antenna

1—The Mosquito's fuselage is formed in halves. Skins of resin-bonded plywood with a layer of balsa wood sandwiched in between are bent over a concrete form, held in place with clamped steel bands. 2—Cold-set casein glue, which holds the sandwich together, is dried under banks of infrared lamps. 3—Formed fuselage halves are placed in big cradles, bulkheads and rib sections installed, wiring and fixtures put in place. Strips of spruce pasted along edges keep moisture out of balsa. 4—Two cradles are then pushed together and halves adhered with casein glue

ALL PHOTOS, COURTESY DE HAVILLAND OF CANADA, LTD.

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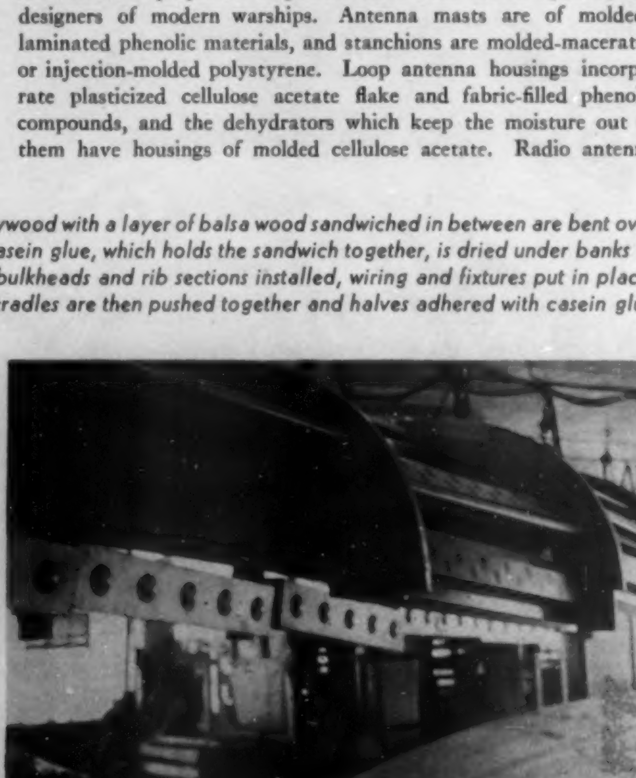

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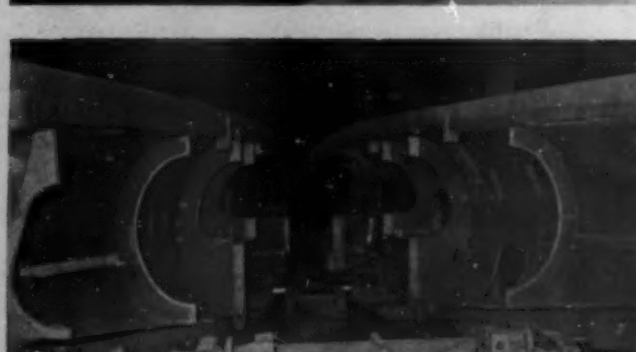

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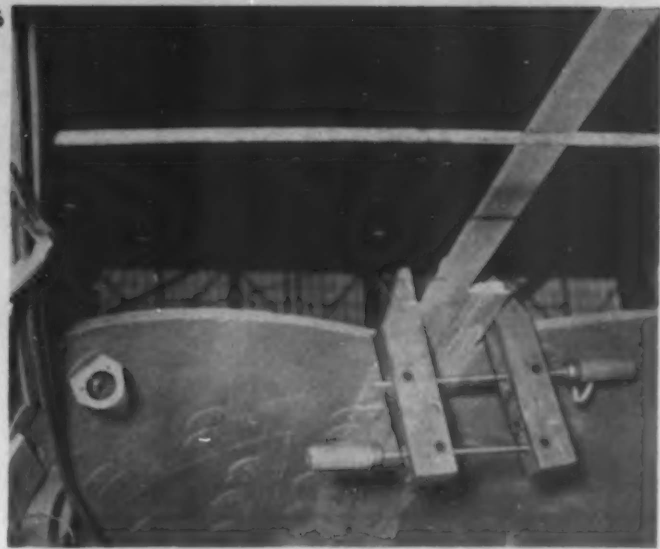

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reels of fabric-base laminate are constructed to resist drag of antennae.

7

The entire radio circuit is studded with molded phenolic plastics, as are those of the lighting, control, intercommunications and motor systems. Circuit breakers, switch boxes, toggle switches, panel boards, sockets, connectors, terminal blocks, switch box covers, meter boxes, terminal boxes, junction boxes—all take advantage of the excellent electrical qualities of this plastic material and its ability to withstand extremes of temperatures. Insulation for wiring systems of all varieties is provided by conduits of vinyl chloride acetate.

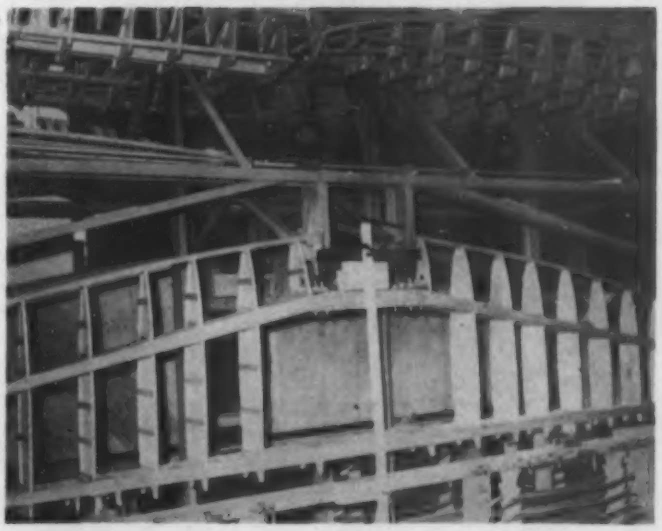
For night flying, when the plane's lights must be extinguished, illumination of instrument panels, switches, nameplates, dials and charts is made possible by laminated plastics with wiped-in fluorescent markings or by fluorescent plastic sheeting. Ultraviolet light is the activating medium.

Fabric-filled phenolic compounds and phenolic laminates have displaced metals in such functional aircraft parts as control pulleys, cable tracks, fairlead guide blocks, aileron controls and certain varieties of valves.

8

This more or less classified listing of aircraft plastics takes no account of the numerous miscellaneous applications of these materials in today's warplanes. These include the molded knobs, handles, switches, plates, panels and dials of both thermosetting and thermoplastic compounds scattered throughout the plane. They cover the replacement of rubber by formulations of vinyl chloride acetate in tubing of all sorts, and in such diversified items as windshield wipers, wiring clamps, floor mats, and handles of fire extinguishers —and this same plastic's replacement of leather for upholstery. They extend to such unrelated facts as that ammunition feeds to the machine guns over rollers of cellulose acetate butyrate; that the sensing element in the plane's de-icer is a tiny methyl methacrylate disk; and that when crew members don their oxygen masks, they depend for their very lives on parts molded from phenolic plastic.

9



Just as it is idle to speculate on the duration of this global war, so would it be futile to anticipate changes that will be made in today's warplanes and new types that will be developed before the last bomber begins its run on the target. It is reasonably safe, however, to prognosticate that the planes in the sky at the war's end will contain more plastic materials than those in service in this year 1943.

The four planes discussed below, all different in point of function performed, are representative of those now flying for the United Nations. The Mosquito is noteworthy because it is the first Allied bomber to take advantage of the structural and aerodynamic qualities of resin-bonded plywood. The Caravan is the first of the huge

5, 6—*A boxing jig and woodworking clamps hold fuselage halves in true alignment.* **7**—*Side cradles are removed and fuselage set into a third cradle, which supports it from beneath while it is sprayed with cellulosic paint, and surfaces prepared for attachment of fuselage fittings.* **8**—*Meanwhile wing and tail skeletons of aircraft spruce are glued with casein.* **9**—*Set in upright fixtures, these assemblies are then given skins of plastic-plywood*

10

11

12

13

cargo planes to be similarly constructed. Yankee Doodle is an efficient advanced trainer, also of plastic-plywood. The Beaufort torpedo bomber is interesting because of the experimental work going forward in Australia with a view to incorporating more plastic materials in its construction.

De Havilland Mosquito

To Hitler's other woes there has recently been added a plague of Mosquitos. Mosquitos that dart and dip and dive—Mosquitos that smash cities and in swift reconnaissance flights make photographic note of the damage. No natural insects these, but a millionfold more effective—the Mosquito bomber-fighters now manufactured in Canada by the famed De Havilland factory.

For the first time, bonded plywood has been used successfully throughout the structure of a combat aircraft. These planes are aptly named because, like their pesky insect namesakes, they are hard to spot and even harder to slap down.

Faster and more maneuverable than any German ship which opposes them, they make quick hit-and-run raids, frequently serving as incendiary bombers which light the targets for the big boys, and then swing around to take pictures of the damage done by the heavy bombers.

Although these low-wing monoplanes may not be particularly beautiful to look upon, they are real fighters and the terror of enemy flyers. The construction of the Mosquito is in many respects rather unique. The fuselage is formed in halves; one skin of precut plywood is placed over a concrete form and scarf jointed, using casein aircraft glue. Then a layer of balsa wood is placed over the skin and another skin of plywood placed over the balsa wood, forming a sandwich with the balsa between the two layers of plywood. The curvature of this sandwiched fuselage is maintained by placing over it a number of steel bands held at a tension by clamps at both ends of each band. These bands are then left in place for a sufficient length of time for the plywood to take the shape of the concrete form (see Fig. 1). In order to speed the drying process of the cold-set resin, the completed half fuselage is placed under a bank of infrared lamps about 50 ft. long. These lamps are thermostatically controlled so that if the temperature becomes too warm at any given point of the fuselage, a sufficient number of lamps can be turned off to cool the fuselage properly (see Fig. 2). After the fuselage halves are formed,

10—*This workman is attaching strips of plywood to fuselage to simplify installation of instruments.* **11**—*Plywood wing skins are laid over skeleton and glued in place, then clamped down until they set.* **12**—*Inside the fuselage, wiring and connections are installed.* **13**—*A vinyl material is used for insulating wiring systems throughout the plane.* **14**—*To hold interior fixtures, plywood disks like this one are used. After the phenolic center plug has been sunk into the plane's side and glued, fittings are screwed into a threaded brass insert which runs through its center*

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14

15

15—*Another view of two cradled halves of fuselage shows workmen installing ribs and fixtures.*
16—*Plywood skin sections must be smooth and perfectly aligned before infrared lamps are turned on to speed setting of the glue*

16

each is put into a huge wooden cradle (Fig. 3) and is ready for further work. At this stage of the process, the bulkheads and rib sections (also made of wood) are placed inside the fuselage halves, and wiring and fixtures are put into place. All along the edge of each half-fuselage, strips of spruce are placed flush with the plywood so that no moisture can get into the balsa and cause swelling and consequent cracking. Both spruce and plywood are impregnated with phenol-formaldehyde resin.

After the interior supports and work are completed, the two cradles are pushed together and the two halves of the fuselage adhered with the cold-set casein (see Fig. 4). The two fuselage halves are held together by a metal fixture with crossed arms known as a boxing jig. This boxing jig achieves two purposes: first, it acts like a clamp in holding the two halves together; and second, it makes certain that the two pieces are in true line and fitted properly through a rather unique method of attaching the jig to the fuselage. In addition to the clamp action of the boxing jig, regular woodworking clamps are placed along the top strip of plywood, as can be noted in Figs. 5 and 6.

The side cradles (Fig. 3) are then removed and the assembled fuselage is placed in a cradle which holds it from beneath. While it is in this position, workmen spray it with a cellulosic paint, and also perform finishing operations on the surfaces where other parts are to fit into the fuselage (Fig. 7).

While all this work is being done on the fuselage, men are forming and shaping the wings and tail surfaces in another section of the plant. The skeletons of the wings and tail surfaces are formed of aircraft spruce, and are also adhered by cold-set casein (see Fig. 8). The skeleton wings and tail are then put in a large, upright fixture where a skin of plywood is placed over them (see Figs. 9 and 11). The surfaces are also glued with a casein glue, and are held to the shape of the skeleton by a series of clamps until such time as the glue has set, and the skin becomes an integral part of the wing or tail surface. The wing and tail surfaces are then sprayed, painted and ready for assembling into the fuselage. The wing section presents a difficult assembly job in that the engines and engine nacelles are, of course, metal, and a method had to be devised to join metal and wood to form a structurally correct and strong unit in the wing. Here the use of plastics was again helpful because the fitting piece between the metal and the wood is a laminated phenolic. This prevents the metal from cutting into the wood and warping its shape. A similar type of laminated phenolic is also used on the hinge packing where the rudder is attached. Most of the large fittings are laminated phenolic.

Throughout the plane the wiring system is insulated with a vinyl material (see Fig. 13). Instead of the anchor knots that would be used to hold interior fixtures such as box plugs, flashlights, etc., on a metal plane, a wooden disk has been devised with a center insert of phenolic threaded with brass. This phenolic insert is plugged into the side of the plane and glued with casein. After the disk has been sunk into the plane, the brass thread may be used for inserting screws to hold equipment in place (see Fig. 14).

The company is experimenting some with bag molding processes to shape some of the surfaces. However, the method of stretching over concrete forms has seemed to work out satisfactorily. One of the desirable features of this type of construction is that some of the smaller pieces can be farmed out to ordinary woodworking establishments which are currently not very busy on high priority war work. Also in its favor is the fact that unskilled labor may be used in many operations.

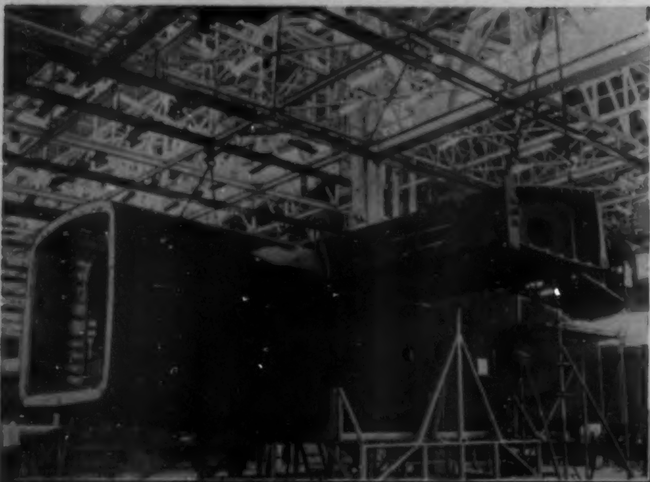
Considerable speed was achieved in getting this plane from the drawing-boards into the air, which was done in a little over a year. One of the principal objections to the plane was that, owing to its construction, it would have insufficient armament, but its speed and maneuverability have far outweighed this drawback. The fighter carries guns placed at strategical positions throughout the ship. Included in its armament may be four 20 mm. cannon and four .303 machine guns.

The plane is operated by two men seated side by side, and it is constructed to give a maximum frontal view. It is powered by two Packard-built Rolls-Royce 1250 horsepower engines. The Mosquito travels at an incredible rate of speed, being able to keep about 300 yards ahead of its own sound when traveling on a level. Its maximum rate of speed is still a military secret. It has a remarkably short turning radius, and with just one engine this aerodynamical miracle can execute tight turns, steep climbs and gliding dives.

In tests the Mosquito was brought down within 50 ft. of the ground with full power on, then jacked into an upward roll. Ordinarily a plane would fall off to regain the lost speed and momentum, but the Mosquito continued to climb several thousand feet. Its first use in combat was when the Nazi-Quisling headquarters at Oslo were knocked into the scrap heap.

The plywood and plastic resin construction has an additional advantage in that bullets make clean holes when they penetrate, which means that the streamlining of the plane is not particularly destroyed by a bullet hole. In metal planes a bullet hole creates a jagged edge which catches the air slipping over the metal surfaces and destroys the streamlining effect to a considerable degree. Streamlining is one of the principal reasons why the Mosquito attains the

17 ALL PHOTOS, COURTESY CURTISS-WRIGHT CORP., AIRPLANE DIV.



18 *17—Renouncing the glory of precision bombing and brilliant fighting, the sober Curtiss Caravan serves faithfully the logistics of global war. Plodding steadily from station to station on its appointed run, it deposits parachute troops, air-borne infantry, airplane repair parts, guns, shells, jeeps and reconnaissance cars where anxious units of fighting men are waiting such reinforcements. From wing tip to distant wing tip, from blunt nose to rounded rear, it is fashioned of molded and flat aircraft plywood and laminated wood, all held together with phenolic and urea resins.* **18**—*Here the cargo plane's center panel of 9-ply resin-bonded plywood is fitted into the fuselage.* **19**—*Production breakdown drawing of the Caravan shows the variety of parts fashioned of plastic plywood. Only simple hand tools are necessary for replacing any component part of a damaged Curtiss Caravan*

19

20—*Interior view of the monster flying freighter. Troop benches which line the sides weigh only $5^1/_4$ lb. per passenger space, are of airplane plywood and routed solid lumber. In middle background they are in "down" position, ready for use. In foreground, they are held upright to make room for cargo.* 21—*Interior close-up shows construction detail: molded plywood fuselage stringer held to flat plywood covered fuselage rings with wood glue blocks*

terrific speed that it does. The smooth wood surface, with no rivets, is the most perfect example of minimum air resistance that has yet been created in aircraft.

So like many a soldier on the world's tropical battlefronts, the German soldier and the German people will spend a number of sleepless nights due to the incessant droning of Mosquitos overhead, and the fear inspired by their sting.

Curtiss Caravan

Practical considerations necessitated by war economy dictated the use of plastic-plywood throughout the huge Curtiss C-76 Caravan, a high-wing monoplane designed as a cargo carrier for the military.

The most obvious of these considerations, naturally, is negative—the need for conserving stocks of metal. Of the positive arguments in favor of the plywood ship, an important one is the availability in the United States of appropriate wood species—hickory, spruce, poplar, birch, gum and Douglas fir. Of equal significance is the feasibility of subcontracting a large share of the work to woodworking companies, where supplies of labor and machinery not engaged directly in war production were to be found. Still another consideration is the suitability of this type of aircraft for operations in areas where there are few facilities for the repairing of metal planes.

The plastic-plywood plane has a wing span of 108 ft. and an overall length of 68 feet. It is powered with two twin-row Pratt & Whitney 1200-horsepower engines, and has landing gear of the retractable tricycle type to assure maximum maneuverability on small landing fields. Its cargo floor is only 36 in. from the ground, facilitating rapid loading and unloading of cargo. Wings of the Caravan are of the conventional two-spar, box-type construction. Wing spars are of laminated spruce cap strips, with plywood webs, internal diaphragms and stringers. The fuselage is of semi-monocoque construction. Plywood of which the ship is built ranges from three-ply (leading edge skin) to nine-ply (center panel).

The control compartment is situated above the forward section of the cargo space and accommodates pilot and copilot, with provision for a radio operator when one is needed. Each plane is equipped for towing gliders.

Characteristics of the plastic-plywood cargo plane include low landing speed, excellent take-off, low stalling speed, moderate range and cruising speed, and ability to transport paratroops, air-borne task forces, field artillery and other military cargo over runs of 1000 miles and into airports unsuitable for existing air transport equipment. An important feature of the plane will be its ability to carry any component part of a damaged sister ship except the fuselage. Light and sturdy wall seats which can be folded out of the way when all fuselage space is to be occupied by cargo will be available for troop-carrying missions. These benches are of aircraft plywood and routed solid lumber. A steel cross-tube in the back takes the safety-belt load and transmits the load to the fuselage rings. The benches are unusually light in weight ($5^1/_4$ lb. per passenger) and extremely strong. Another important feature of the Caravan is that provision is made for a fuselage cable to which the release cord of paratroopers' parachutes may be attached.

The plastic-plywood construction used for various parts of the Caravan is of three main varieties. The following parts of the plane are molded: fuselage exterior skin; wing skin; nose wheel doors; paratroop door; stabilizer tip skins; dorsal fin leading edge skin; some fuselage stringers; tip skins of rudder and elevator; and tail cone skins.

In addition, the following surfaces are covered with flat aircraft plywood: control surface tabs; cargo floor; webs of built-up spars, wing and tail surface ribs, fuselage rings; and empennage skins

22

22—*Trim training craft is Fairchild's Yankee Doodle, molded of plastic-bonded plywood by the Duramold process. Rubbed aluminum paint with a synthetic resin base gives this advanced trainer the appearance of a single glittering piece of highly polished metal*

ALL PHOTOS, COURTESY FAIRCHILD AIRCRAFT DIV., FAIRCHILD ENGINE & AIRPLANE CORP.

23

except as noted above. Laminated wood is used for spar caps, fuselage ring caps, some stringers, some compression members, etc. The plane's transparent enclosures are formed from acetate sheet.

It would be difficult to determine without a detailed study the actual number of plywood parts involved in the plane's construction, and such an enumeration would depend on what constituted a "part." Each drawing of a wood sub-assembly calls for many plywood parts, and many thousands of such parts go into the fuselage alone.

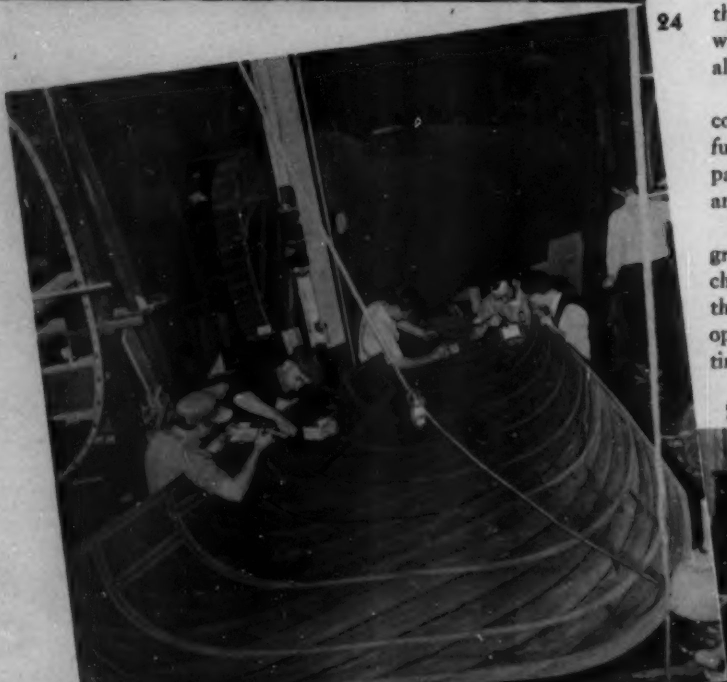
All molded plywood skins and assemblies and flat aircraft plywood are bonded with phenol-formaldehyde resin. Urea-formaldehyde is used for all assembly operations. Phenolic glue, when set, will not decompose from the effects of heat, and the finish applied to the plywood gives it an exceptionally smooth surface. Vibration tests of the plane's parts have been satisfactory.

Although it is not proposed to use the Caravans at the battle front, if one should come under fire it is expected to withstand gunfire better than a metal transport, for a bullet will tear a smaller hole in wood than in metal. As for incendiary bullets, a given concentrated heat will take longer to burn through the Caravan's wood than through aluminum.

Figure 19 shows the breakdown of the plane's structure into its component parts. To assemble, the pilot's coup top is glued to the fuselage. The center panel is bolted to the fuselage, and outer panels are bolted to the center panel. The empennage, stabilizer and vertical and dorsal fins are bolted to the fuselage.

Available non-strategic materials and studies made of the various gross weights, power plants, wing loadings, take-off and landing characteristics which are desirable for this type of operation dictated the design of the C-76. Leaders in airplane manufacture, airline operators and War Department representatives were consulted from time to time.

24



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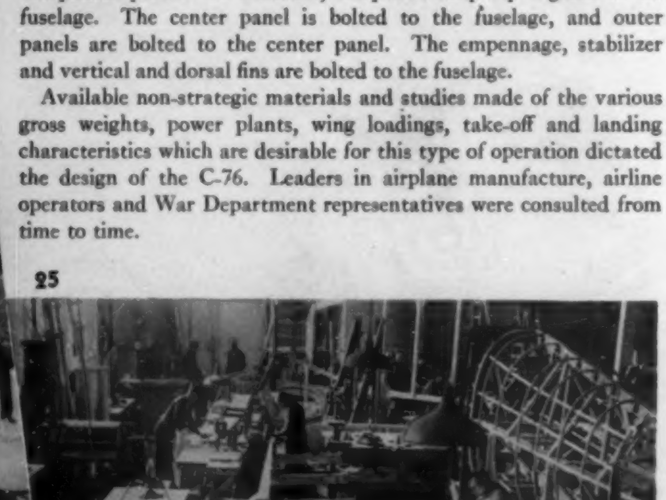


23—*Women make deft workers in the Fairchild plant. Here they are fitting the strips of aircraft plywood which form the trainer's fuselage.* 24—*Glue is applied to the inner side of the rear fuselage's plastic-plywood skin so that frames and stringers can be set in place.* 25—*When assembled, this outer wing panel will be covered with skins of preformed plywood, held in place with cold set urea adhesives, and set into the trainer's fuselage*

Before actual engineering designs were completed, a stationary wind tunnel model and a powered model were made and given wind tunnel tests. Handicapped by the complete lack of information on the strength properties of the wood used, it was necessary to make about 50 specimens of wood constructions of individual parts and static test them to destruction.

Selected as main subcontractors for the Caravan were the Mengel Co., of Kentucky, manufacturers of plywood tobacco hogsheads, plywood for PT boats, ammunition boxes, Curtiss airplane crates and wood automobile parts; the Baldwin Piano Co., of Ohio; and the Universal Molded Products Co., of Virginia. Some 65 percent of the Caravan is subcontracted to these firms.

Assembly of the first few of the aerial freighters is underway in Curtiss' Missouri plant, but the bulk of the aerial freighters will be produced in another giant factory in Kentucky, designed exclusively for mass production of the C-76.

The War Department has selected the Curtiss Caravan design as the airplane which Andrew J. Higgins will construct in New Orleans to augment production of the Curtiss organization.

Fairchild Yankee Doodle

The only way to train bombardiers and gunners is through practice in actual flight. The Fairchild AT-21 was designed to be one of the best training planes for this purpose. Of molded plywood, manufactured by Fairchild's Duramold process, the AT-21 differs from some other molded plywood planes in that its external surfaces are not covered with a doped fabric but only with a waterproof paint. This gives it a smoother finish than most other aircraft and speeds its production.

Another point in particular of the AT-21 is that the plywood is merely bonded with a phenol-formaldehyde resin, and not impregnated with the resin.

As the veneers originally come to the factory, they are only about 6 to 10 in. wide. They are trimmed and jointed on a machine which applies a hot set urea adhesive to the edge at the same time. Then, in order to get wider sheets, the strips of veneer are edge joined under heat and pressure by a special machine. After gaining sufficient width to cover the molded form which they are to take, the layers of veneer are placed in the mold.

The method used is to place the layers of veneer (in the case of the AT-21 this veneer is mahogany and poplar) either over a male or within a female form. In between the layers of veneer are sheets of phenolic-impregnated paper. Adjoining layers of veneer are laid at right angles to each other to give more uniform strength and better stability against warpage and (*Please turn to page 152*)

26

27

WIDE WORLD

28

26—Standing shoulder to shoulder, workman apply nailing strips to skin on outer wing panel. **27**—*Center section skin of resin-bonded plywood formed by the Duramold process.* **28**—*The first Bristol Beaufort torpedo bomber to be assembled in Australia is here rolled off the assembly line strictly on schedule. Aircraft technologists are constantly working to incorporate more plastic materials in the Beaufort*

Yarn for screens

Plastic-coated yarn customarily used for decorative and costume fabrics, when woven into screen cloth replaces galvanized steel wire and bronze mesh

SULTRY summer days are about the only time when the average consumer worries about screening material, but to the U. S. Public Health Service and many industrial plants proper screening is a year-round problem. In certain areas of the U. S. where malaria is prevalent (now by a rigid antimalaria control program confined mainly to the Southern States), the use of screening on windows and doors of homes, mills, factories, hospitals, etc., is a virtual necessity. As a result of the war program, numerous Army camps and war plants have been established in such areas, thus increasing the demand for screening materials.

Manufacturers of insect screen cloth have found difficulty in obtaining steel and copper with which to expand their production because of the many more critical demands for these materials. Experiments with plastics begun before the war, mainly with the idea of securing corrosion-proof, colorful, weather-resistant material, resulted in screens of nylon and extruded saran.* However, restriction of supplies of the basic filaments rapidly caused limitation of production of this plastic screening and withdrew the product from the general market to meet needs of the Government services.

Plastic-coated yarn which can be easily handled on existing equipment is the newest material found to be satisfactory for screening. This material is based on multiple-ply cotton thread twisted tightly and impregnated with cellulose acetate butyrate, over which multiple coatings of the same plastic are then extruded. The yarn is said to be flame-retardant and waterproof, and to have a semi-stiff finish which works satisfactorily on present-day wire screen looms. Conversion to plastics on this machinery requires only slight changes, and aside from a minute contraction in its width during the weaving process, the manufacturer of the cloth has not been difficult. Ordinary textile box looms as well as standard wire looms can be used to weave the desired mesh.

In the interests of economy and simplified production a single color—battleship gray—was standardized, and the yarn is produced in two gages—.015 and .020. Tests by various screen manufacturers indicated that two weights of the material, woven at right angles to each other with the .015 as warp and the .020 as woof, resulted in the strongest screen. The formulation of cellulose acetate butyrate contains a limited amount of plasticizer in order to achieve the requisite stiffness. Thus when woven, the strands form a definitely serrated pattern and hold this shape even when detached from the frame.

One of the principal reasons why this material was selected is the fact that there is a comparatively large stockpile available. It is reported that at present the manufacturer has 36 machines capable of producing 1500 to 2000 lb. of the plastic-coated yarn per day, or about 600,000 lb. per year. If and when steel wire is taken away from screen manufacturers, they will need enough plastic-coated yarn to produce 500,000,000 sq. ft. of 16-mesh screen cloth, or about 3,000,000 lb. of yarn. To meet these requirements, the plastic yarn manufacturer is building 100 additional improved machines which will provide increased and speedier production of approximately 1,500,000 lb. per year. The yarn is claimed to be resistant to salt water, stable under cold and heat, and to require no galvanizing or lacquering after weaving. Its finish is permanent and it will not stain or discolor. Its light weight facilitates economical shipping.

While cellulose acetate butyrate has been used for this particular yarn, a wide range of resins, plasticizers and solvents can be used in the manufacture of these plastic-coated yarns, the formulations depending upon the requirements which the yarn must meet. In essence, a support which may be of any type of yarn—cotton, rayon, linen or Fiberglas thread (or even wire)—is fed through a plastic mixture and into a series of dies which determine the final diameter of the finished plastic-coated thread.

The machine is essentially a frame of sheet iron containing the following elements: two containers in which are deposited the plastic to be used; a series of dies attached to the containers for the purpose of controlling the amount of plastic applied directly to the yarn in each application; and a heated chamber through which the coated yarn passes in its journey from die to die. The thread travels through the plastic and then through the first die, which allows a minute quantity of plastic to remain on the thread. It then passes through the chamber, which is heated sufficiently to dissipate the solvents, and goes into the second container of plastic and through the second die, where a second coat of plastic is applied. The yarn can continue to travel back and forth, and on each trip will receive another infinitely fine coating of plastic. The number of trips or passes that the yarn makes is dependent upon the finished diameter required. The yarn may receive as few as 6 or as many as 24 individual coatings, one over the other. Upon its completion, the yarn travels to a wind-up mechanism which spools it. Pigmented or translucent finishes which permit a certain amount of light to pass through the individual strands can be produced. Yarn can be made by careful controls either soft and flexible or, as in the case of screen cloth, a fairly stiff yarn. When a rigid yarn is required, the weight of the basic thread can be relatively thick so that an adequate but minimum quantity of plastic is required for coating.

Special yarns have been produced. One which has become standard as a serving cord for electrical insulation aboard ships is unusually strong and flame-resistant. It is based on nonflammable, sturdy Fiberglas thread covered with an abrasive-resistant coating. Other lightweight, colorful plastic-coated yarns produced by this same process have been used in (*Please turn to page 140*)

Durable screen cloth woven from yarn coated with cellulose acetate butyrate is light, dimensionally stable, resists salt and air corrosion

PHOTO, COURTESY FREYDBERG BROS.—STRAUSS

* MODERN PLASTICS *20*, 50 (Sept. 1942).

Birth of an Army canteen

TODAY, whenever a parched Johnny Doughboy stops to ease his thirst with a swig of water, there's a good chance that it may be from a plastic canteen. This newest marvel of the plastics industry has been over a year a-borning, but out of the trials and tribulations attendant upon its birth has come a canteen with unique and superior properties. Aluminum and baked enamel can't take the tests which this super-tough water carrier must meet. But more about the tests later, for even more interesting than these tests is the history of how the plastic canteen ever came to be.

Back in the fall of 1941, the Plastics Section of the Quartermaster Corps called a meeting in Washington to discuss the possibility of a plastic canteen. It was foreseen that aluminum would soon be unavailable for such an application and it was thought logical that plastics might do the job. At first, the feeling was that only a high-impact phenolic or vinylidene chloride canteen would hold up under the field treatment which such an article was certain to undergo. Those present at this meeting tried to imagine what treatment might be given the canteen in normal Army service, and thus set up rough standards which it would have to meet.

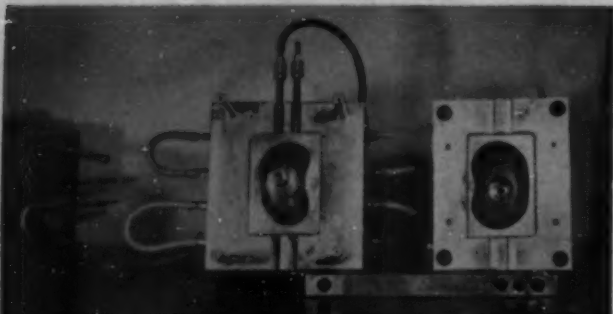
Two weeks later, at another meeting, a report given on the high-impact phenolic canteen said that the job as anticipated could probably be done in phenolic, but made an adverse recommendation to doing it in this thermosetting material.

In the early months of 1942 another meeting was held at the offices of a large material manufacturer. Further details of the properties desired in an Army canteen and the properties of various materials being considered were discussed at this gathering. Cycles, pressures and heats were also gone over in detail.

After thorough consideration of all thermoplastic materials, ethyl cellulose was chosen as that which had the most promise. Initial tests indicated that it would be satisfactory with regard to most of the necessary military characteristics with the exception of taste. The difficulties in overcoming this taste objection took an immense amount of work and time both in formulating of materials and in testing of the product. When a sufficiently tasteless product was obtained, an extensive field test was undertaken at Camp Lee with several formulations of ethyl cellulose and vinylidene chloride. These tests indicated that the ethyl cellulose canteens would be a satisfactory substitute for aluminum and stainless steel, with a few minor modifications. It was then decided to place an experimental order for the improvement in the formulation and the design of the canteen and to submit these canteens to an extensive field test by Service Boards. Several more meetings were held before the QMC placed an experimental order for 50,000 canteens, split among five molders.

This canteen was a tough job to lick. Time and again when it looked as if the bugs had been ironed out of it, new flaws appeared on further testing. For the QMC wasn't satisfied with a plastic canteen which would be a mere substitute: it drew up specifications that would ensure that it would be a better product than its predecessors. Hundreds of hours of machine time and of engineering skill were used up in testing various methods of molding and various material formulations. For example, 28 formulations were made, 40 different curing cycles and temperatures and 10 different methods of cementing were tried before a satisfactory canteen was molded.

Comparatively simple things made a tremendous difference so far as successful completion of the job was concerned. In one instance, a molder found that by merely reversing his cementing process better results were obtained. Figure 4 illustrates this point. Originally cementing was done by placing the bottom half of the canteen in the lower part of the jig, affixing the top half to it and then applying pressure to hold the top and bottom halves in firm contact along the weld line. However, it was found that under pressure the bottom half—which was longer in its vertical dimension than was the top half—tended to bulge outward to such an extent that it caused an imperfect seal between the two halves. This was remedied by reversing the position of the top and bottom halves so that the top half was placed in the jig upside down, the bottom half then placed over it, and pressure applied. The jig holding the top half extends up slightly, so that when the bottom half is welded to the top half, the former won't spread along the weld line because a lip of the jig holds it in place. *(Please turn to next page)*



ALL PHOTOS, COURTESY AMERICAN INSULATOR CORP.

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Finding a satisfactory solvent to form the weld was also a problem. One company which is producing a very satisfactory molded canteen discovered that a solvent of 89 percent benzol and 11 percent alcohol made the best weld. To ensure uniform application of the solvent on all points of the edge surfaces of both top and bottom halves, this company rigged up a clever device which has worked out very well. It consists simply of a pan—leveled by a spirit level—filled to a predetermined point with the solvent. The two canteen halves, are placed in this pan with the surfaces to be welded placed in the solution.

At one point in production, this same company found that the employees who were putting the two halves together were removing from the edges to be welded what they thought was excess solvent. They were doing this by scraping the exposed surface along a straight edge. Actually they were weakening the weld because their scraping operation was not uniform, and more solvent was being scraped off some places along edges than was being removed from other places. This naturally caused improper adhesion between the two welded halves. However, when the scraping procedure was stopped, everything was all right again. Weld procedure is so efficient now that this molder has one girl operating four jigs and pressure appliances.

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After the halves have been welded with the solvent under 300 p.s.i. pressure, they are loaded into trays which are stacked on a portable tray holder and rolled into a huge oven (see Fig. 6). They are dried in this oven much more uniformly and much faster than if allowed to dry normally. When they are completely dry, they go through the finishing and testing operations where excess solvent is removed and the tests (described later in this article) are applied.

The actual molding of the canteens is extremely well done. Both halves are center gated, the lower half on the bottom and the top half on top of the neck of the canteen. The gate on the canteen neck is removed by a driller and that on the bottom by a milling operation.

According to one company's procedure, the bottom of the canteen is injection molded in a single-cavity mold (see Fig. 2) on a 6-oz. machine. The cycle is 56 seconds. The top of the canteen is injection molded in a single-cavity mold on a 2-oz. press in a cycle of 56 seconds.

5

The tests applied to the canteen are unbelievable, but all a matter

1—Mold and cavity for the upper half of the ethyl cellulose canteen. Note that cavity is gated at the center of the neck of the canteen. Since this piece is punched out, no gate marks will show. 2—Mold and mold cavity for bottom half of canteen. Gate is on the bottom, and the small mold mark will not mar the appearance of the finished canteen. 3—The operator inserts the top half of the canteen in the jig preparatory to cementing. 4—Operator puts bottom half of the canteen in the jig over the top half, at the same time removing with her right hand a canteen which has already been cemented. Note that the inverted bottom half of the canteen fits down into the jig slightly, thus preventing the bottom half from spreading along the weld line when pressure is applied. 5—Here the operator is preparing to apply pressure to the two molded halves of the plastic canteen in the jig by means of a clamping device

of record according to Army specifications. Before quoting a few of these, however, it is even more sensational to note that when an ordinary five-passenger motor car ran over one of the canteens filled with water, it showed not the slightest amount of leakage, no dents, no distortion and only slight abrasions on the surface.

Specifications

Dimensions. The side walls of the canteen have a minimum thickness of 0.090 in., the bottom 0.110 inch. The canteen with cap and chain cannot weigh more than 7 ounces. It must contain a minimum liquid content of 910 cc.

The color of the canteen conforms to Standard No. 3 Olive Drab. The interior of the canteen must be clean and free from all foreign bodies.

Tests

Impact test. One of the plastic canteens is completely filled with water, the cap is screwed on tightly and the canteen is dropped from a height of 10 ft. to a concrete surface, taking care to drop the canteen in such a manner that the cap does not strike the hard surface. The drop is repeated once, and the canteen examined for fractures. This test is to be conducted at a temperature of 77° F. ± 2° F.

Freezing test. A second test canteen is filled to 90 percent of its total capacity with water, is capped tightly and is subjected to a temperature of −10° F. for 24 hours. The canteen is examined for fractures and for failure at the cemented shoulder.

Low temperature impact test. The canteen used in the freezing test is dropped immediately after removal from the low temperature, from a height of 6 ft. to a concrete or other hard surface, and then examined for fracture.

Hot water test. A third canteen without the cap and filled with water at 180° F. is placed for one hour in water maintained at 180° F. The canteen is examined for warpage, distortion and softening.

Boiling water test. A fourth canteen, without the cap, shall be filled with boiling water and allowed to stand for five minutes. At the end of this time it shall be placed in Cup, Canteen, M-1910 or M-1942, and allowed to stand for one-half hour. The canteen shall then be inspected for warpage, distortion and softening.

Taste and odor test. A fifth canteen is filled with distilled water, capped tightly and placed in an oven maintained at 110° F. After 24 hrs. the water is examined for taste and odor.

Pressure test. Each canteen, not less than 24 hrs. after it has been assembled, shall be fitted with a cap to which is attached a suitable tube, equipped with pressure gage and shut-off valve, leading to a supply of compressed air and immersed in a water bath. Air pressure of 25 p.s.i. is applied to the canteen. Failure of the canteen is shown by appearance of bubbles and shall be taken as cause for rejection of the canteen.

Cap and chain assembly strength test. The cap shall be removed from the sixth canteen and firmly clamped to the edge of a table. The canteen, filled with water, shall be held in an upright position to the limit of the chain, extending vertically to the chain, and shall be permitted to drop freely so as to subject the chain to a sharp jerk. Test shall be repeated 10 times.

Cap strength test. A canteen filled with water, with cap screwed down tightly, shall be dropped from a height of 10 ft. onto concrete so that the edge of the cap is hit on initial impact. There shall be no cracking, breaking, or other failure of cap when tested at 77° F. ± 2° F.

Although at present the canteen is being made of ethyl cellulose, experiments are still going on which will enable the QMC to determine whether cellulose acetate butyrate material will serve for the application. [In a forthcoming issue of MODERN PLASTICS there will be a complete story on another method of producing the canteen from cellulose acetate butyrate.—ED.]

Truly, today's soldier has the finest equipment money can buy, and high on that list is the new ethyl cellulose canteen.

Credits—Material: Ethocel. Molders: American Insulator Corp., General Industries Co., Mack Molding Co., Chicago Molded Products, Inc., Amos Molded Plastics, Division Amos-Thompson Corp.

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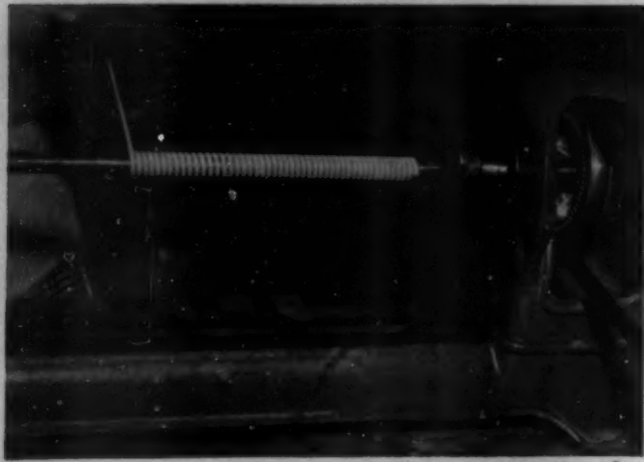
6—After the canteen halves have been welded together with a solvent under 300 p.s.i., they are loaded onto trays. These in turn are stacked on a portable tray holder and wheeled into a huge oven, where they are dried. 7—The two injection molded halves of the plastic Army canteen, together with the finished canteen. 8—An aluminum canteen after it had been subjected to the impact test—dropping from 10 ft. to a concrete floor

1



2

Air hose for life rafts

No fortune teller is needed to predict that a flood of interesting applications will follow the war uses of a plastic tubing which is now being supplied to the Army Air Forces as a low-pressure air hose for life rafts. The type of air-conducting tubing which the Air Forces selected is an all-plastic product, but because it must withstand a $-70°$ F. temperature in these life rafts, the customary plastic outer sheathing has been replaced by one of rubber.

The prime requisite of this tubing is that it be in a workable condition at all times so that there shall never be the slightest delay in the inflation of the life-saving rubber raft. Such a hose obviously demands maximum strength and durability, and additional requisites for this particular hose are flexibility and resistance to severe weather, and it must not kink nor collapse.

The complete unit consists of a spiral core of plastic which is inserted in a tubular sheath with a covering jacket of cotton. The flexible core is made of extruded cellulose acetate butyrate, a compound offering exceptional hardness and a minimum of dimensional variation. Its spiral form is attained by winding the material on a mandrel, as illustrated in Fig. 1. One length of spiral is wound on this mandrel, fastened into position with a clamp, and then placed in a hot oven for a short period of time. After the material has had a chance to soften in this elevated temperature, it is then removed from the oven and permitted to cool to room temperature. After this alternate heating and cooling, the spiral wound tubing will hold its shape after it has been removed from the mandrel.

Fig. 2 shows the method of inserting the extruded butyrate spiral rod into the outer sheathing to complete the tubing. In this picture a section of the fabric has been cut away at the top to show the rubber underneath. With the spiral still wound tightly on the mandrel, the rubber and fabric sheathings slip easily into position. After this assembly operation the spiral is released from the mandrel and quickly expands, making a tight and flexible assembly.

Figure 3 is a close-up of tubing still on the mandrel showing cutaway sections of all three units: the inner core of spiral wound flexible cellulose acetate butyrate; the outer sheathing, which in this case is rubber; and the covering jacket of braided cotton. Figure 4 shows the unit as it appears when ready for shipment to the Army Air Forces. The sections are 12 in. long and $^3/_4$ in. in diameter.

This plastic tubing may be used for purposes such as air and liquid lines, as guide cables for push-pull controls or as electrical conduit of the coaxial cable type. Depending upon the nature of the application, the material for the spiral core is selected from several of the harder rubber-like thermoplastics—cellulose acetate, cellulose acetate butyrate, ethyl cellulose, polystyrene or hard vinyl chloride. The outer sheathing is at present made of extruded vinyl chloride, although other flexible plastics may be used.

Although the plastic tubing replaces rubber and metal, engineers of the manufacturing company claim that it is not a substitute product but particularly stipulated because of its advantageous qualities of lighter weight and complete non-conductivity. Use of the outer jacket, which is of loom woven cotton treated by dipping in varnish, is optional. The tubes can be manufactured in any diameter and any reasonable length.

Credits—Material: Tenite II. Duoflex tubing extruded by Detroit Macoid Corporation.

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Ventilation en route

Forward and onward marches the multitude of devices which have grown from the need of material replacement and developed into products of increased efficiency. One of the latest recruits is a small transparent plastic vent for the circulation of fresh air in airplane and glider cabins.

The Snapvent, as the piece is called, is of simple one-piece construction, fabricated from clear, flexible cellulose acetate sheeting. It can be installed in a few minutes in a plastic window or sheet metal cowling with the aid of a twist drill and a half-round file. Two vents and a steel radius guide are packaged as a unit.

The installation of the vent is made by drilling a $^{3}/_{16}$-in. hole in the window at the center of the desired opening. The radius guide is then fastened in the hole, and with a drill fastened in the free end of the guide the material is cut in a clockwise direction, stopping just before the circular opening is completed. The slight projection at the end of the cut is removed by a half-round file, and the ventilator is snapped into place without more ado. It can be just as easily removed for cleaning.

The usual setting of the vent is with the opening toward the nose of the plane. This admits the fresh air without the noise and draughts accompanying open windows. During a rainstorm, the vent can be turned to form a suction and draw out the stale air in the cabin. The vent effects a neat, efficient closure. It is lighter than aluminum, rust-proof, does not impair visibility and costs less than aluminum. Army and Navy aircraft are being equipped with the plastic ventilation device.

Credits—Material: Lumarith. Snapvent invented and fabricated by Burton B. Simcox.

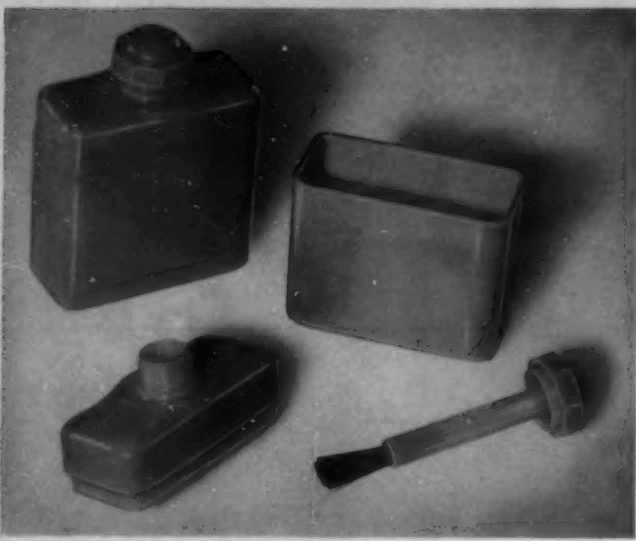
PRODUCT DEVELOPMENT

Chemical range finder

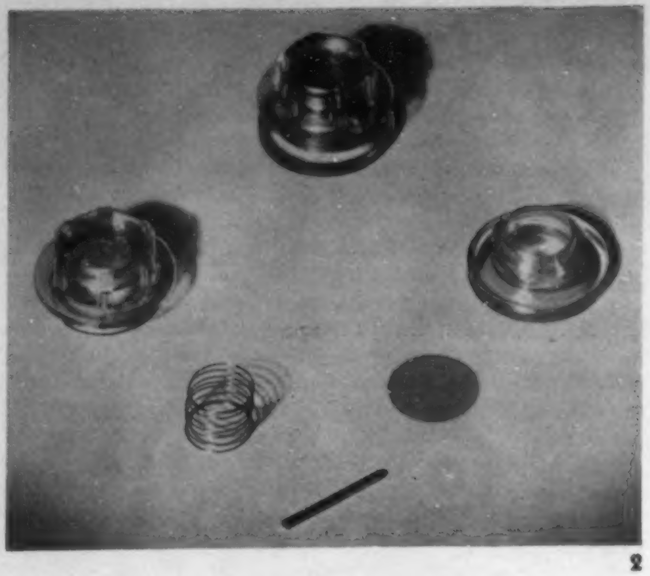
Chemical warfare is highly specialized science and its tactical maneuvers must be performed with precision. In addition to releasing gas clouds which drift with the wind toward enemy lines, chemical warfare agents can now be employed in almost any place that explosives are used.

Aerial bombs, artillery and mortar shells (see photograph), special chemical projector shells, land mines, hand and rifle grenades can be filled with destructive materials, but their effectiveness depends upon the accuracy with which they are handled. To aid the CWS artillerymen, light, legible range finders made entirely of cellulose acetate, have been developed. These white cards, measuring $5^{1}/_{4}$ in. by $3^{1}/_{2}$ in., are cut from cellulose acetate sheet approximately $^{1}/_{16}$ in. thick and are stamped with black block roll-leaf paper on an embossing press. Both sides of the chart printed with this indelible inlay contain easily read information which facilitates range finding. The plastic cards won't fray or bend under rough wear, and can be cleaned with a damp cloth.

Credit—Material: Fibestos. Fabricator: E. B. Kingman Co.; Roll leaf equipment: Peerless Roll Leaf Co., Inc.



PHOTOS, COURTESY M. WINTROB & SONS, LTD. 1



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1—Oil container for Bren gun is molded of cellulose acetate butyrate in 4 pieces with molded-in threads. It costs one-third as much as its metal predecessor and can be turned out twice as fast. 2—Aircraft oxygen mask's air inlet valve is injection molded in 2 pieces of polystyrene, chosen for its resistance to physical changes at low temperatures and high altitudes

Canada's plastics industry in wartime

by HIRAM McCANN

APPROXIMATELY 90 per cent of the output of the plastics industry in Canada is now devoted to war, and the past twelve months have seen more new products developed by that industry than the previous twelve years. That's the story in a nutshell—but the efforts of individual processors and technical experts which have brought about this development make another impressive story.

Canada entered the war in September 1939 with few facilities for plastics production. Not more than a half-dozen large firms were molding radio and electrical parts and consumer goods such as knobs, handles, accessories, novelties, etc. A small amount of cellulose acetate sheeting was being processed, and plastic was being used as an interlayer in combination with glass in windshield manufacture. Little use was being made of plastics in wood laminating because few of the new resin glues were in active employment in Canada, although three or four firms had equipment for this type of work. One of the chief reasons for this lack of prewar development was the fact that, as regards thermoplastics in particular, it was often cheaper to import them from the United States than to set up production lines for limited Canadian consumption.

Today all that has been changed. The Empire Air Training Program, which has turned out thousands of pilots, bombardiers, gunners, navigators and radio men, necessitated the building of training planes in Canada, especially after British production was tied up following Dunkirk, and this brought into being a wood aircraft industry which is still expanding. Now at least five large concerns are making parts for wooden planes or complete assemblies in eight plants between Winnipeg and Montreal. The new synthetic resin glues proved here to have great advantage over the former animal and vegetable bonding materials, because they are stronger, resistant to all physical and chemical elements encountered in aircraft operation, and practically impervious to water, fungus and bacteria. Two general methods are used for plywood bonding for aircraft: the hot setting thermosetting method, and the cold press plastic method. Two of the more important jobs of this type are the Anson trainer, which is made partly by Bristol Aircraft at Belleville, Ont., and partly by the Cockshutt-operated new Bristol plant at Brantford, Ont., and the De Havilland Mosquito bomber made by De Havilland Aircraft of Canada, Ltd., at two plants near Toronto.

MacDonald Brothers Aircraft, Winnipeg; Massey-Harris Co., Ltd., Fairchild Aircraft of Canada, Ltd., Montreal; Dominion Plywood, Limited, Southampton, Ont.; Commonwealth Plywoods, St. Therese, Que., are also engaged in plywood bonding for aircraft and other purposes. Of course, the chief reason for this switch to wooden planes is the saving of aluminum; but plastic-bonded plywood has now proved stronger, lighter, cheaper and even more resistant to tracer fire than aluminum, so its future in aircraft manufacture is assured. Furthermore, wooden airplanes can be made anywhere with little personnel training, and the use of subcontract shops is facilitated—an important matter in Canada, where a small population is spread over a great area.

Shortly after Dunkirk also, a scarcity of metals developed in Canada. The country's war production facilities expanded very rapidly and metals were in heavy demand for field and naval guns, tanks, motor vehicles, small arms, machine guns, corvettes, freighters, planes and ammunition. The need for plastics to replace these metals wherever possible was urgent, and the plastics molding industry received a vigorous push ahead.

The thermosetting molders expanded and such companies as Canadian General Electric Co., Ltd., and the Stokes Rubber Co., Ltd., Welland, Ont., stepped into high-quantity production of fuze caps for shells and bombs, concussion grenades, radio and electrical parts, etc., while Mack Moulding Co., Ltd., Waterloo, Que., went into high gear on radio component parts using electrical low-loss mica-filled phenolics; and Hale Brothers, Ltd., Montreal, increased production of radio parts and other items. Research Enterprises, Ltd., Toronto, a Government-owned company managed by Col. W. E. Phillips, long in the plastics business as head of Duplate of Canada, Ltd., Oshawa, Ont., developed a phenolic tank periscope-holder that saved Canada a quarter of a million dollars as compared with the cost of the same article developed in metal.

Thermoplastic molders also increased production facilities and trained new workers. Two good examples are the Plastics Division, Reliable Toy Co., and M. Wintrob and Sons, Ltd., both of Toronto, who have turned from novelty molding to war equipment making. An example of their value to Canada in wartime is found in the oil bottle for the Bren gun. This item used to be made of cadmium-

plated brass; now, made of thermoplastic, it costs about a third and can be turned out twice as fast! The former company is also manufacturing millions of thermoplastic bullet tips for the South African Government.

There are now twelve molders of thermosetting materials in Canada and about twelve companies manufacturing thermoplastic items and laminating plastics. The industry is largely concentrated in Ontario and Quebec, though by no means confined to the larger cities. Since only two plastic molding materials are produced in Canada—phenol- or urea-formaldehyde and vinyl acetaldehyde —many molding compounds have to be imported, largely from the United States. But the industry is fortunate in having attracted men who know how to cooperate and whose main idea is to win the war as quickly as possible, so there is considerable mutual assistance on technical problems—a vital matter to an industry so newly expanded. The recent establishment of a Canadian Chapter of the Society of the Plastics Industry[1] under the presidency of A. E. Bryne, Canadian General Electric Co., Ltd., is a further result of this cooperative spirit and should materially speed up the broader use of plastics technology in Canada.

As pointed out at the S.P.I. dinner in Toronto last month by E. T. Sterne, Canadian Controller of Chemicals, and the man who is responsible for plastics allocations, the plastics manufacturers of Canada are more interested in licking their problems than in competition. And of great assistance to the industry in problem-licking is the National Research Council at Ottawa, where Dr. W. Gallay and associates are working on research and development of plastics and synthetic resins. The results of their work are made available to the plastics manufacturers in the placing of specific contracts by the Department of Munitions and Supply. It frequently happens that one order from M.&S. may be split between two companies working from identical molds. Several university chemical professors are also helping with the research, notably Dr. R. V. V. Nichols of McGill University, Montreal.

Out of these conditions and through this cooperation in the industry have come notable savings in metals by the use of plastics as alternates and also the creation of new plastic product designs which are bound to bring this war-stimulated industry more and more efficiency now and after the war. In the field of thermosetting plastics, one of the outstanding jobs is a smoke grenade fuze made by both Duplate Limited and Canadian General Electric Co., Ltd. This unit has three plastic components and is further complicated by having three different sizes of threads, one female and two male. The whole job is molded by transfer from a material especially chosen for its chemical properties, which are such that it will not affect explosives. It saves weight in grenades, saves metal, brings the cost down and speeds up production. Canada's plastics industry can take pride in these pieces, which were first used in the field at Dieppe. Another firm is making a concussion grenade shell complete from plastics. Innumerable other parts of ordnance or military goods are made either by transfer or injection. One worth mentioning is a cable connector part for aircraft in which up to 36 metal inserts for connection have to be molded in.

Work on redesign of metal castings to permit use of plastics is going on constantly and every day sees a new development in this field, saving metal, labor, time and shipping weight. Plastic materials are now quite as strategic as metals in Canada. Fortunately, all this research work has given them genuine engineering recognition and placed them on an even footing with metals. Another result of research and development has been that, while before the war designs frequently had to be changed to suit a limited range of plastic materials, now compounds can be reformulated to fit the design, giving the whole industry a new versatility.

The thermoplastic molders are also doing their share, as mentioned above. In addition to the oil cans of high acetyl cellulose acetate, there are air inlet valves for oxygen masks and radio parts made of polystyrene. A mixture of vinyl and phenolic resins is being used for flexible wire coating. Cellulose acetate sheeting is appearing in civilian gas masks. Imported from the U. S. and fabricated here are acrylics used in aircraft manufacture.

A recent project is that of Canadian Resins & Chemicals, Ltd., Montreal, an affiliate of Shawinigan Chemicals, Ltd., which is manufacturing a host of vinyl acetate copolymer products, all the way from fabric coatings for army raincoats, hats, etc., to heavy cable coating. The material is now being considered (*Please turn to page 154*)

[1] See MODERN PLASTICS *20*, 62 (Feb. 1943.)

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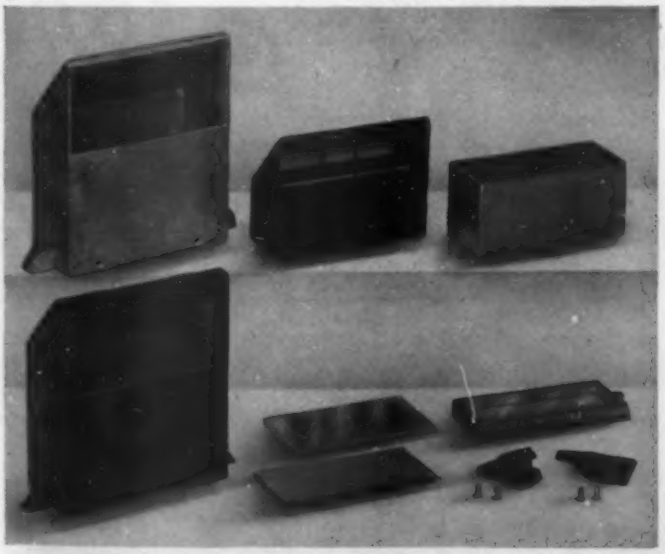
PHOTO, COURTESY RESEARCH ENTERPRISES, LTD.



3—Upper prism holder for tank periscope, formerly machined from aluminum casting, is now molded of phenolic plastic. 4—A group of parts for aircraft and Army field use, also molded of phenolic material. 5—A binocular adapter eyepiece and eye mount lens which saved some 6000 lb. of aluminum and 78,000 man hours of labor when they were redesigned to be molded of phenolic material

PHOTO, COURTESY CANADIAN GENERAL ELECTRIC CO., LTD.

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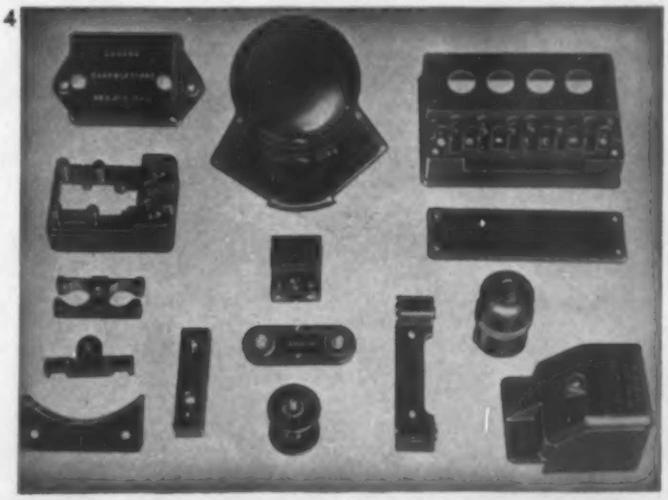

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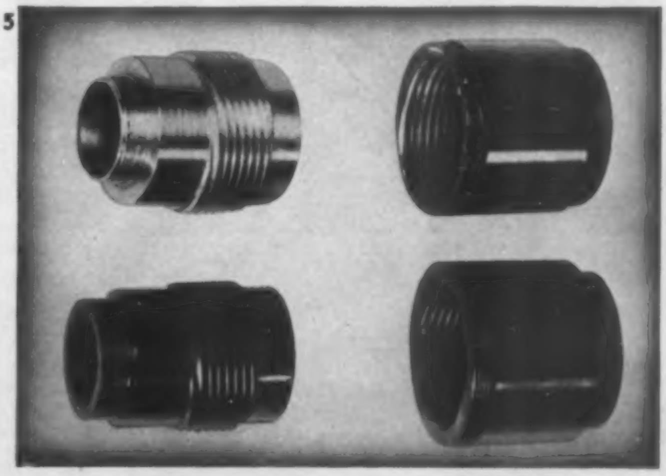


Electroplating masks

by R. R. BRADSHAW*

INJECTION molded saran masks are being used today in the plating of vital aircraft parts indispensable to the maintenance of high aircraft motor production schedules. This thermoplastic resin has pioneered the way in opening a new field of plastic operations by solving an age-old masking problem that has plagued America's electroplating companies.

The process of applying chromium, nickel, copper, silver and other metals to any machined tool or part by means of immersion in either acid or alkaline solutions, to deposit the metal on the desired area by electric current is, under normal conditions, a difficult job requiring a high degree of skill and accuracy. In a majority of cases, only a limited section of the part needs to be plated. The problem of distributing metal on this small section so that it will not creep into areas that must not be plated and completely spoil the whole part, has confronted all industries engaged in electroplating.

There were four known methods of masking in use by the plating industry before saran was developed. Many companies utilized masking tape, a method not adaptable to chrome plating. Some employed what is termed "stop-off" lacquers, a process with limited practicability depending on the plating solutions to which they were subjected. Authorities have claimed that any lacquer has a very low efficiency in electroplating procedures. In addition, the method was costly and consumed valuable time in application and removal. Wax was another method which was satisfactory for most plating solutions provided the temperature of the acid or alkaline solution was not too high. Rubber also was employed as a masking material and, although a critical war item, was found to work satisfactorily in all plating baths except chromic acid solutions. Because many vital airplane parts have surfaces chrome plated to resist wear, a new masking material for this type of plating was badly needed. None of these methods was completely satisfactory in all plating solutions. Result: time was being wasted.

In peacetime, the loss of a few minutes of operating time did not greatly concern plating companies. But today the loss of one, two or three minutes in strained production schedules means not only lost profit but also a loss of equipment needed by American soldiers on the war fronts. Since the loss of time factor became so important, it was evident that a new masking device manufactured of a material containing properties enabling it to withstand any plating cycle was needed at once, if plating processes were not to be responsible for a lag in war production.

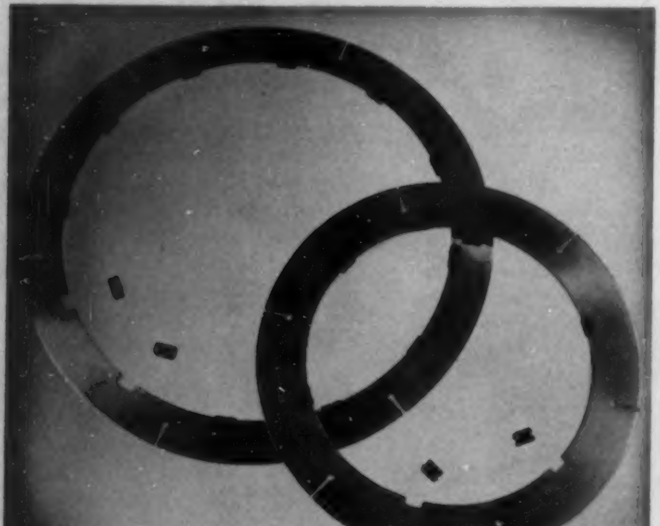
Material manufacturers have kept in constant touch with new production problems where there is a possibility that plastic materials could be more successful than ordinary products in industrial and commercial applications. The resiliency, high resistance to chemical corrosion and ability to withstand heat of saran mark it as a product worthy of consideration in the electroplating field. However, before saran was recommended to the plating industry, samples of several plastics, including saran, were secured and put through a series of exhaustive tests to ascertain which possessed necessary properties for plating masks.

Parts masked with molded plastic were put through the plating cycles of nickel, chrome, silver, indium, cadmium, tin, lead, copper and zinc. Each plating cycle had wide temperature variations and contained such chemicals as sulfuric acid, nickel sulfate, silver cyanide, etc.

Tables I and II show the time elements, solutions and temperatures brought into play in the complete cycles of chrome and nickel on steel, two plating metals used frequently in parts manufactured for war production. The tables show the procedure followed with each plastic-masked part during the experiments.

Each plastic mask was minutely inspected and checked to ascertain its reaction and ability to stand up under the severity of actual electroplating operations. Because of saran's unusually high chemical resistance, its reaction in each chemical solution was excellent.

* Dow Chemical Co.



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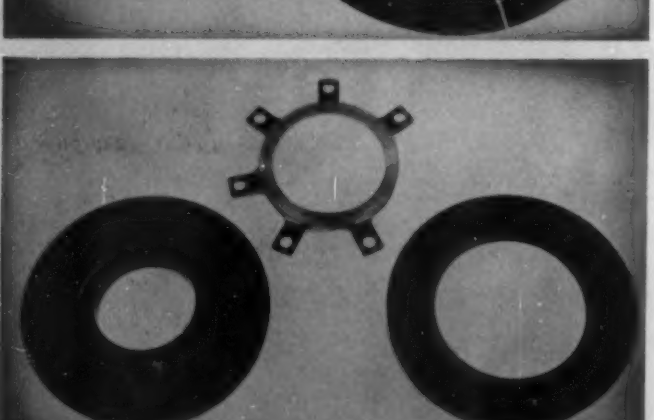

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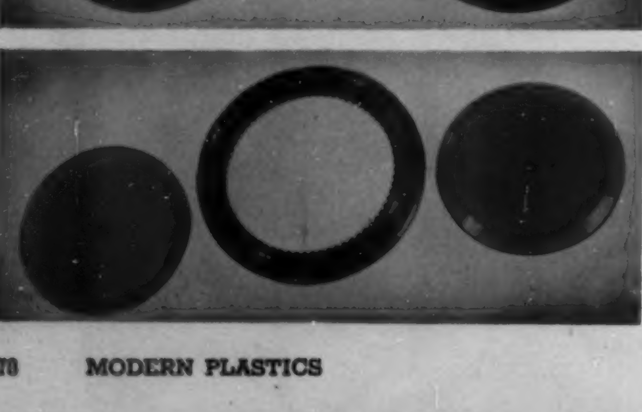

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Because the older methods of masking metal proved time-consuming when large quantities of aircraft parts required chrome plating, a new material was developed for electroplating masks. **1**—*Indentures on this steel aircraft ring are protected from metal deposits during electroplating by covering the sections with tight-fitting caps of saran.* **2**—*Aircraft part fits into two housings of the injection molded compound. Only a few seconds are needed to place plastic masks in position. Lacquer methods usually require several hours.* **3**—*The inside toothed area on this aircraft part is protected by two saran cover masks which snap into place*

Other products submerged in the same bath equipment did not stand up under the high corrosive action of the mixtures. This achievement alone was significant, but its ability to withstand the heat of the various plating and cleaning baths, many running as high as 200° F., was amazing. Its resiliency also was important, for it ensured an accurate, tight-fitting mask.

Old masking methods did not offer flexibility in solving the individual problems brought up by each plating job because they were general in scope. For instance, tape, lacquer or wax was used in the plating of all parts, no matter how difficult or involved the application might be. These methods constantly revived three annoying problems: time consumption, lack of dependability due to adhesion difficulties with the masking material, and resultant high production costs caused by the great number of rejected parts.

It was possible, of course, to develop a saran lacquer or tape that could be applied to machined parts according to the old methods. But this would have meant the same loss of production time and would have engendered the same awkward problems. All these considerations were completely studied before saran was introduced to the plating industry. Instead of recommending the use of saran as just another general method for the plating industry, the peculiar difficulties of each plating job were studied separately so that a masking design for that particular job might be molded. The Kaydon Engineering Corp. is responsible to a great extent for the design flexibility of saran masks.

The following is a group of unusually tough masking problems that were solved with specially designed saran masking units:

Articulated pins manufactured for airplane motors by one of the large aircraft companies required silver plate on everything but the bearing surface, the two ends and the two holes running horizontally through the part. Other methods proved inadequate. Usually the entire part was plated, necessitating laborious grinding off of the silver covering undesirable areas, a wasteful and expensive operation. Four saran injection molded plugs for the holes, two plugs for the ends, and a molded sleeve of the same plastic to protect the bearing surface cut this company's operating schedules to the bone. Older systems required hours; a rack full of saran-masked parts was assembled in 39 seconds.

Chromium Corp. of America experienced trouble in finding a masking material that could withstand concentrated acid solutions and offer absolute accuracy in the protection of regularly spaced slots on the inner circle of a steel aircraft ring which needed chrome plating. Masking with tape, lacquer and wax had proved impracticable. Saran masking caps (Fig. 1) were found to possess the desired accuracy and to be able to withstand the concentrated plating baths, thus effecting for this war plant a great saving in time.

Limited areas on many aircraft parts require chrome or nickel plating to ensure hardness and long life. Several similar parts needed slightly different design treatments, which were provided for with injection molded saran masks in the form of housings (Figs. 2–3) into which parts were snugly fitted, leaving only necessary sections free for the deposit of metal. If stop-off lacquers were used on these parts, they would have to be immersed in lacquer, the areas to be plated scraped clean of all particles of lacquer and the parts put through the proper cycle to plate a small space only. In addition, any lacquer remaining on the parts would have to be completely scraped away. Several hours would be consumed by this method, while the plastic can accomplish the same work in a few minutes.

Table I.—Chrome Plating Cycle

1. Vapor degreasing—hot trichlorethylene.
2. Clean in an alkali cleaner, time 2 to 5 min., temperature 200° F.
3. Cold rinse.
4. Electrolytic etching solution of sulfuric acid with reverse current for 1 min.
5. Cold rinse.
6. Chrome plate in standard chromium plating solutions at 120° F. to 130° F. Time depends on coating required. Approximately 1 hr. is required for each .001-in. coating.
7. Hot and cold rinse.
8. Blow off with compressed air to dry.

Table II.—Nickel Plating Cycle

1. Vapor degreasing—hot trichlorethylene.
2. Clean in an alkali cleaner, time 2 to 5 min., temperature 200° F.
3. Cold rinse.
4. Sulfuric acid dip, time 1 min., temperature 75° F.
5. Cold rinse.
6. Nickel plate in nickel sulfate solution, temperature 135° F. to 140° F. Time depends on coating required.
7. Cold rinse.
8. Hot rinse, 180° F.

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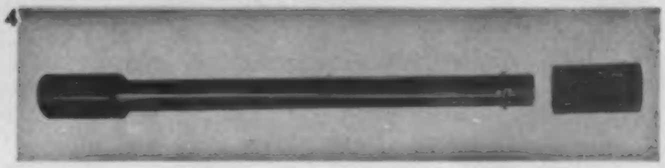

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4—Threaded areas in two 4-in. tubes of saran screw onto the ends of a 20-in. brass aircraft rod to prevent deposits on the threads and inside the tube. 5—Two masks fit closely over an aircraft valve chrome-plated on the inside. Plating solution enters through one end of the plastic mask, does not come in contact with outside area of the valve

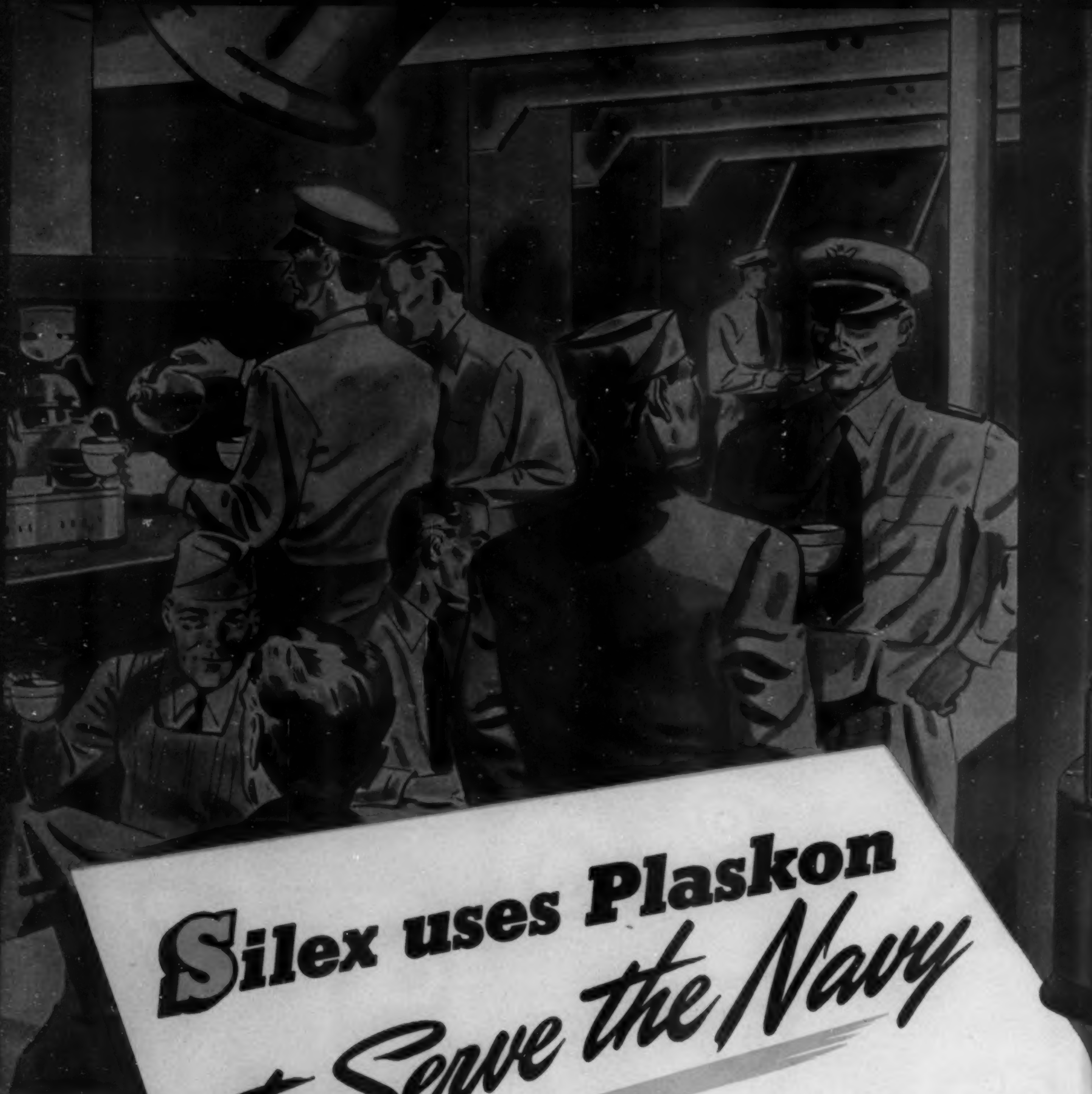
Brass aircraft rods approximately 20-in. in length by $1^1/_4$-in. in diameter needed copper plate on everything but the threaded areas at either end and the inside section of the rod. Tape and lacquer were formerly used as masks. The difficulty was to prevent copper solution from depositing metal inside the tube. Two open saran tubes 4-in. in length were constructed with threads to match those of the rod, and screwed on tightly, allowing proper provision for electrical contacts (Fig. 4). To prevent metal deposit inside the rod, plastic masks were made an extra inch in length. Time, money and material were saved on this application.

Plastic masking units were also found to be highly successful in offering desired protection for carborized areas on parts requiring copper or other metal plating.

Aircraft tee parts had to be nickel plated everywhere except the threaded sections. Masking protection for the part was similar to that devised for the brass rod. Three open saran tubes were molded to fit the threaded parts, hangover of the masks preventing deposition inside the part. The ease with which the plastic can be machined and threaded with standard tools minimized time involved in making the masking units.

Aircraft valves must be tin or chrome plated only on the inside, necessitating utmost accuracy to prevent coating the outside of the valve. General methods, due to poor adhesion of the mask, deposited metal on outside areas and resulted in a great number of rejects. Saran met the problem with two masks designed to fit over the entire valve, allowing plating solution to enter only through one end of the mask (Fig. 5).

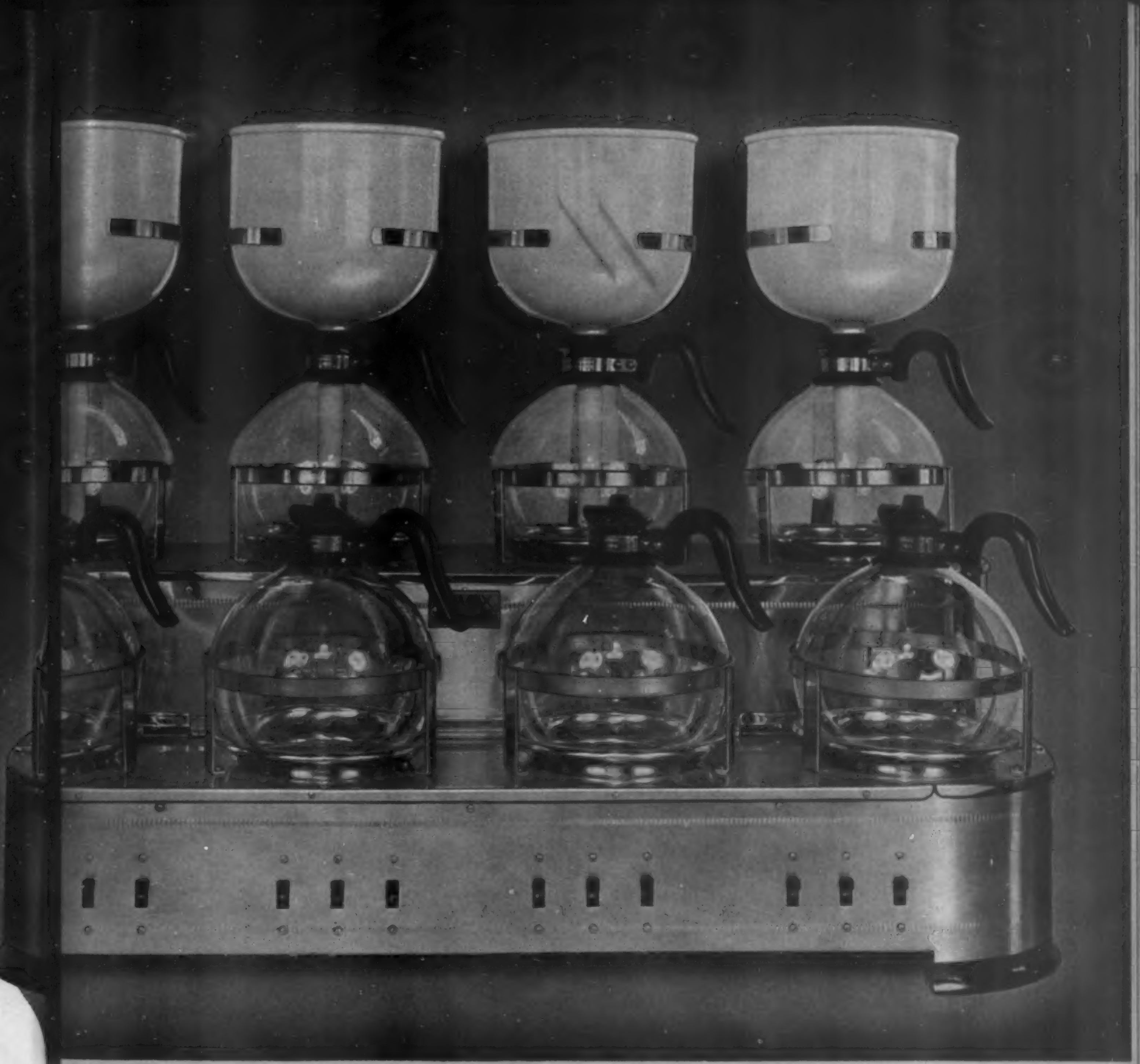
One of the most significant of the saran masking operations was the Rolls-Royce cylinder-liner mask. Cylinders are plated by the Packard Motor Car Co. and used in the production of airplane motors. The entire outside diameter of the cylinder is nickel plated with the exception of $^1/_2$ in. on the top and bottom. A masking device was needed capable of handling two cylinder sleeves simultaneously. Snug-fitting top, center and bottom plates, into which the sleeves fitted one on top of the other, were (*Continued on page 136*)



Silex uses Plaskon *to Serve the Navy*

Round the clock there's coffee brewing in the Navy... for stimulation and good cheer on every watch... for revival of the rescued... and to top off every meal. Silex Coffee Makers, equipped with top bowls, neck rings and handles of Plaskon Molded Color, now are used to brew much of this delicious beverage for our naval forces.

Two major problems were met by this new use of versatile Plaskon melamine-formaldehyde plastic: Breakage of glass, and its attendant dangers, largely has been eliminated; and, vital metals are being released for uses which they alone can serve. Although Plaskon Melamine Compound is an extremely light material, with specific gravity of only 1.48, it possesses strength quite out of proportion to its weight. It can withstand sharp blows and concussions, and does not dangerously shatter or splinter.



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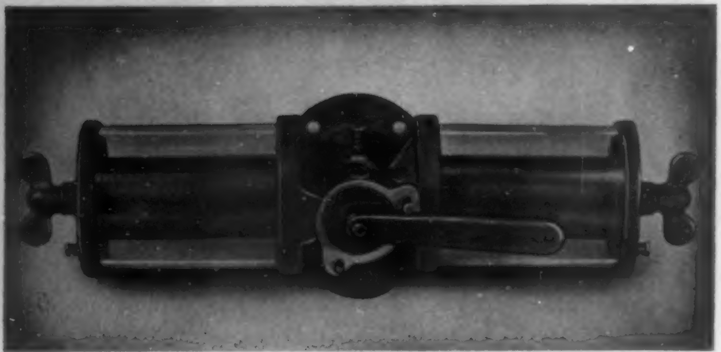

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Plastics in Review

1 Keeping watch from a lonely post exposed to the elements is an important and an uncomfortable assignment. To keep observers warm and comfortable, the transparent plastic dome above has been devised to surmount observation posts of the Antiaircraft Artillery Command (EDC), whose units are located along the East Coast. The dome is made from strong, weather-resistant Lumarith sheet and provides adequate shelter with no sacrifice of visibility. At the same time it prevents such interference with transmission of messages as may be caused by sounds of wind, weather and the sea

2 This picture was snapped "somewhere in Africa"—land of hot days and cold nights, violent sandstorms and torrential rains. It shows an American air base built by native labor under the direction of Pan American Airways engineers. The buildings are constructed of Weldwood, a phenolic resin-bonded plywood manufactured by U. S. Plywood Corp., and flown out from this country by air after rigorous tests. The bases were speedily erected and P.A.A. has been assured of their durability despite the unusual climatic conditions, since the resin bond is impervious to moisture, bacteria and fungi

3 This one won't fly off the handle! It is a substantial canvas plastic mallet manufactured by Penn Fibre & Specialty Co. and designed for hard or delicate hammering or forcing work. It is known as the Penn mallet, and a fabric-base rod stock produced by Synthane Corp. and the Taylor Fibre Co. is the material from which it is fabricated. Superior endurance in hard usage is its long suit. The manufacturer states that it will not chip, splinter nor cause a spark; that it is waterproof and will outwear all ordinary mallets. It is very light in weight and other factors in its favor are heat resistance, good tensile strength and electrical resistivity

4 Engineers may now watch the operation of water filters for marine engines through transparent barrels fabricated of Lucite. When conditions within the filter barrels can be observed, clogging of the cooling system and resultant overheating of the engine are avoided. As one filter becomes clogged, the other is turned on, and the dirty filter cleaned. The method has been so successful that the manufacturers, Gross Mechanical Laboratories, have adapted it to their entire line of filters. The tough, lasting methyl methacrylate will withstand hard knocks

5 Transparent identification tags for school children are being injection molded of Fibestos by Plastex Corp. Cellulose acetate was selected for this application to meet the requirement for a free-flowing material adapted to the deep draw and thin walls of the part involved. The acetate compound was also suitable for molding a piece with smooth, round corners which will not cut or scratch sensitive young skins. Because of its non-toxic quality, the tag may be put into the child's mouth without danger of poisoning. A tiny card bearing the child's name and address is slipped into the 2-in.-long acetate sheath

6 A creep-mouse now rides the wing tips of T.W.A. skyliners, carrying a gleam from the navigation lights under the edge of the wing tip to the upper edge where pilots can see it. This device tells the pilot whether his lights are on and aids in night maneuvering at low altitudes by locating the exact position of the plane's wing tips. "Mousey" is formed from a bent rod of Lucite, light-conducting methyl methacrylate resin of slight weight. Fabricated by Transcontinental & Western Air, Inc., by cutting and forming sections from $^{1}/_{2}$-in. half-round rod, the light-conductors are fastened with metal clamps as shown

7 Bits of plastic scrap hit the nail on the head with a bright idea emanating from Norton Laboratories. Thumb-tack heads are made by molding shop salvage of Durez over the metal studs, saving metal and utilizing waste material. The compound gives a smooth finish and offers a wide assortment of colors, solid and mottled. The shape evolved for the thumb-tack head offers a good grip, and the pin is well anchored to prevent breaking off by finger pressure. Various grades and types of materials can be mixed together and molded, since no specific physical properties are required

8 As a replacement for chromium-plated die-cast metal, Globe Tool & Molded Products Co. has selected molded Lumarith for making toilet seat and cover hinges. Each hinge consists of 5 parts. Those fitting into the vitreous bowl are molded over heavy screws (at right) and are the only parts using metal, all the cores in the assembly being of wood. The metal replacement is rust- and corrosion-proof and is easy to keep clean with a damp cloth

9 The signal light housing at the top of this manual push button station, which is a standby for automatic systems in case of fire, is drawn from transparent red Fibestos sheet to a thickness of .060 inch. The foremost problem of the fabricator, Ira L. Henry Co., in making this unit for the Cardox Corp. was to obtain proper preheating of the sheet. This was worked out by using a cellulose acetate material. Dies were reportedly very simple and worked smoothly. The light in the housing is on at all times, enabling workmen to spot instantly the nearest carbon dioxide release station

10 The State of Utah is avoiding unnecessary use of metal by molding sales tax tokens of Tenite. The plastic token is light in weight yet has withstood abrasive wear from constant handling. Tokens are molded, 80 at a time, by Ingwersen Mfg. Co., Inc., by the rapid injection method. No stamping or polishing is required and tokens are ready for use when they are clipped from the runners. Since scrap may be ground up and used over again, there is no waste of material. Different colors denote the token values

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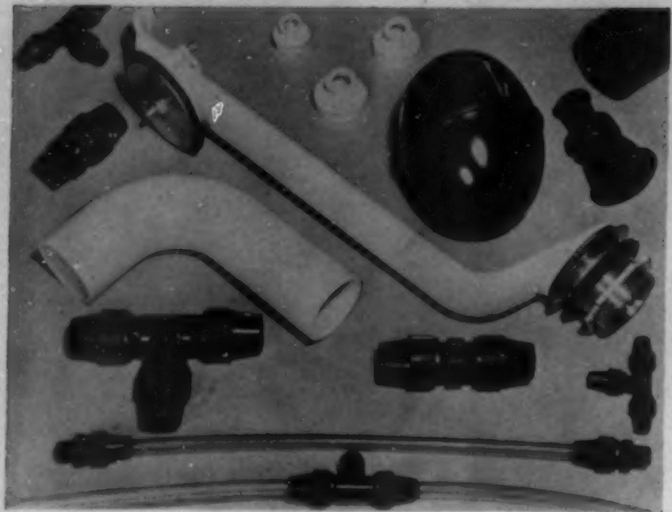

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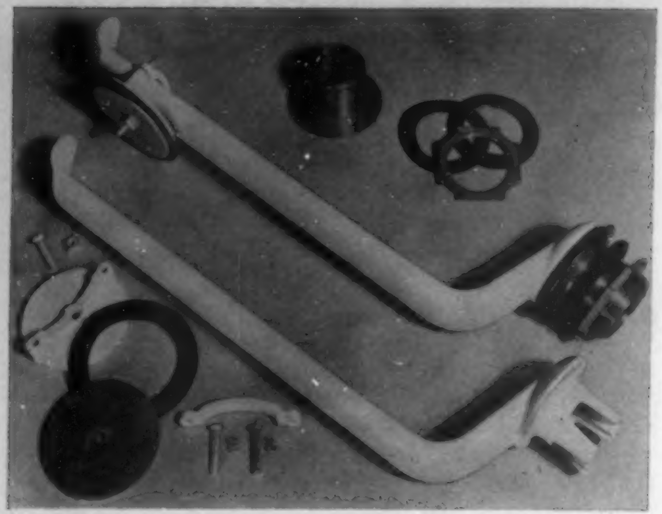

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1—In wartime housing projects, industrial plants, plastic plumbing fixtures preview applications for postwar buildings, replacing rubber and metal. Elbows, stoppers, float balls, showerheads, range and stove connectors, and other fittings are representative items. **2**—*An easily installed drain is shown assembled, and with its component parts*

Modern plumbing fixtures

ECONOMISTS tell us that, in the decade following the war, the country will absorb between 1,200,000 and 1,500,000 new homes. Many of these will be small prefabricated units, which architects and designers agree will be reduced to a minimum number of units, such as heating, refrigeration, kitchen and bathroom. For these homes of the future, floor, wall and ceiling panels of plastic-plywood are already being designed, and plastics will be found also in many of the integral fixtures of the prefabricated house.

Plastics have already taken their place in the manufacture of almost every plumbing fixture in the modern home. A partial list of such items assembled by one company, the Bloch Brass Co., Plastics Division, includes pipe and fittings such as elbows and nuts, closet tank trim, bath drains, stoppers, closet tank supplies such as floats, balls and flush tubes, shower head, and water supply connections for lavatory, wash basin, tub and shower. In addition, tubing and fittings for range and stove connections are found, along with a variety of plumbing items for the kitchen sink such as extruded plastic trim, strainers, plastic traps and J tubes.

The materials used depend on the requirements of the particular application. They include polyvinylidene chloride (saran), cellulose acetate, cellulose acetate butyrate and polystyrene. The parts are welded or cemented from extruded or injection molded sections to form complex curves and achieve functional designs which could not be otherwise obtained without using complex, elaborate or expensive molds.

This company, which has had a long history in the brass industry, several years ago began experiments with plastic bathroom fixtures and other plumbing items, and put the new developments under test, thus establishing a background for a future plastics program. Consequently, when the war stimulated the demand for plastic plumbing fixtures, and the brass shortage speeded the changeover to plastics, the company was able to pace its distribution of metal and then of plastic parts with the changing Government orders and requirements of its customers.

The "Glider" all-plastic bath drain and overflow (see Fig. 2) is made of cellulose acetate butyrate. All parts are inside the tube and are readily installed in any standard tube without having to make alterations. The drain comes complete with strainer plug, washer and upper guide ring with the front and back plate. At present, the strainer plug is made of brass, for which iron will be substituted when present supplies are exhausted. Although the drain is molded in two parts and cemented, no failures have been reported, and it has been thoroughly tested in actual use for over a year. It has been found that the plastic retains its smooth, hard, lustrous finish and does not scratch, tarnish, corrode or discolor. It withstands severe water temperatures and resists the normal chemical content of different waters.

On new installations, "back of tube" piping is eliminated, saving several feet of pipe and several fittings. Not only is the installation simplified and made less expensive, but the material cost itself is greatly reduced. The drain costs about $^1/_3$ as much as the metal equivalent, is easily maintained and in event of damage is quickly replaced since it is 100 percent accessible. It is also adaptable to the cement and wooden tubs which are appearing in some localities.

Range and stove connectors are made of polyvinylidene chloride (saran) extrusions and injection molded fittings and are replacing rubber, flexible metal hoses and rigid piping which were formerly used. The connectors are gas tight and not affected by oil, water or any chemicals found in the fuels themselves. Since saran is crystalline by nature, once it sets there is a minimum tendency to cold flow. The fittings, therefore, once they are well seated on the flared ends of the tubing, maintain their permanent seal.

This same line of saran tubing and fittings is extended to include a shower supply line to a plastic shower head, and the "over the rim" tub fillers discussed below. In addition, the tubing, in any desired length complete with any fittings and connectors required, is used for piping such a variety of materials as beer, fruit juices, beverages, oil, gasoline, alcohol, water, acids, air, etc. (*Please turn to page 136*)

Vinyl compound combats corrosion

SWINGING into aggressive combat in the chemical process field, a powerful ally has joined the forces which work against the destructive elements of corrosion. That ally is a vinyl-based product of various formulations. Following an experimental stage which covered a period of nearly 10 years, it made a brief peacetime début. Today it is on the list of the nation's critical materials and is available only for essential war purposes.

The series of these compounds is said to resist more than 90 percent of all known corrosive agents, which in itself is a big step forward, as corrosion-resistant material for process equipment has long been a problem from the angle of selectivity. No one material has previously been found suitable for all applications. A product which would handle a 20 percent solution of sulfuric acid might break down under a 40 percent solution; equipment which performed satisfactorily at 150° F. might be useless at 175° F.; a lining capable of resistance to plating solutions might go to pieces with the application of current. Thus, resistance of various materials to specific corrosive materials, reaction to heat and thermal shock, tensile and dielectric strength, permanence of bond—these factors must all be taken into consideration in determining the compound to be used. This new plastic compound enters the field as a product prepared with a formula for each specific problem.

The experimental work in developing the present product has been in the hands of D. F. Siddell, director of research for U. S. Stoneware Co., the parent company, which has 12 production divisions in its 7 separate plants, each specializing in one type of corrosion-resistant equipment. The product is known as Tygon and is classified in the chemical trade as a modified vinyl type. The synthetics originate in a series of rearranged basic molecular structures, new condensation resins and diene derivatives compounded, as previously mentioned, into various formulas. Its physical properties vary from bone-hard substances to soft jellies, and each compound can be changed in physical structure by the addition of various plasticizers, coloring or stiffening agents. The physical properties of one type of this group which is of the modified halide polymer variety of materials are listed in Table II.

The data in Table I on the chemical resistance of this material to chemical reagents has been determined in the laboratories of the U. S. Stoneware Co. according to the Tentative Method of Test D 543-39T prepared by Committee D-20 on Plastics, A.S.T.M. The following is quoted from a paper with regard to interpretation of the results of such tests.[1]

TABLE I.—CHEMICAL RESISTANCE OF TYGON

	Change in weight when immersed for 7 days at 25° C.	*Change in weight after immersion for 7 days at 25° C. and subsequent exposure to air at 25° C. and 50% relative humidity for 4 weeks*	*Effect of immersion for 7 days at 25° C.*
	%	%	
30% sulfuric	.04	0.00	None
3% sulfuric	.09	0.00	None
10% nitric acid	.08	0.00	None
10% hydrochloric	.09	0.00	None
5% acetic acid	.11	0.00	None
10% sodium hydroxide	.09	0.00	None
10% ammonium hydroxide	.16	0.10	None
10% sodium chloride	.09	0.00	None
Distilled water	.09	0.00	None
50% ethyl alcohol	.07	0.00	None
Acetone	Dissolved	Decomp. by swelling	Dissolved
Ethylene dichloride	Swells	Decomp. by swelling	Dissolved
Toluene	79.0	16.0	Soft, rubbery
Gasoline	−0.01	0.00	None

[1] "Resistance of Plastics to Chemical Reagents," by Kline, G. M.; Rinker, R. C.; and Meindl, H. F., Proc. A.S.T.M. 1941; MODERN PLASTICS *19*, 59-66, 88 (Dec. 1941).

"The limitations of this method as well as of other test methods involving the permanence properties of plastics should be recognized. The choice of reagents typical of the range of acids, alkalies, salt solutions, solvents and other chemicals which may be encountered in service is necessarily arbitrary. For most applications it will be

1—Small, acid-resisting parts are molded of the vinyl-base compound for industrial applications subject to deterioration from acid action. 2—Steel tank lined with the vinyl material by an exclusive bonding process resists strong oxidizing agents. 3—Strip film of a non-adhesive formulation gives temporary protection for polished surfaces and peels without injury to surfaces

PHOTOS, COURTESY U. S. STONEWARE CO.

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necessary to test the plastic, which is under consideration for fabricating the part, in contact with a particular chemical. However, rather than confine the method to a statement of testing procedure without listing any reagents or extending the list indefinitely to include all compounds and concentrations of solutions proposed by committee members, an effort was made to choose those reagents which would be representative of strong and weak acids, strong and weak alkalies, salt solutions, and the various types of organic solvents, such as alcohols, ketones, esters and aliphatic, aromatic and halogenated hydrocarbons.

"Another limiting factor in the practical value of the results obtained in this test is the relatively short time of immersion specified, namely, 7 days. For applications involving continuous immersion in chemicals, the data obtained in a short-time test are of interest only in eliminating the most unsuitable materials. Furthermore, the criteria of changes in weight, dimensions and appearance are often insufficient to reveal adverse effects of the chemicals on the strength and electrical properties of the plastics. On the other hand, many instances have been reported of industrial applications of plastics in which the surface appearance is marred by contact with chemicals, but the serviceability of the plastic is not appreciably reduced. The period of immersion and the properties to be measured were, as in the case of the chemicals, selected primarily to serve as a guide to investigators wishing to compare the relative resistance to chemicals of different plastics. Those with special problems in the application of plastics under corrosive conditions must necessarily fit to their special needs the duration of contact with the chemical, the temperature of the system and the physical tests used in determining the suitability of the plastic."

The compound can be molded, (*Please turn to page 146*)

TABLE II.—PROPERTIES OF "TYGON T"

Properties[a]	*Unfilled*	*Filled*	*Rigid*	*Plasticized*[b]
PHYSICAL PROPERTIES:				
Specific gravity, g. per cc.	1.33–1.36	1.34–2.45	1.33–1.36	1.26
Specific volume, cu. in. per lb.	20.7–20.3	20.6–10.5	20.7–20.3	...
Refractive index, ND at 20° C.	1.54	......	1.53	...
Flammability		Does not support combustion		Slow burning[c]
Specific heat, cal. per ° C. per g.	.24	[d]	.24	...
Thermal conductivity, cal. per sq. cm. per cm. per sec. per ° C.	.00039	[d]	.00039	...
Linear coefficient of thermal expansion, per ° C.	.00007	[d]	.00007	...
MECHANICAL PROPERTIES:				
Modulus of elasticity, p.s.i.	35,000–40,000	35,000–80,000	35,000–40,000	...
Modulus of rupture, p.s.i.	10,000–14,000	8,000–12,000	10,000–14,000	...
Tensile strength, p.s.i.	8,000–10,000	6,000–12,000	8,000–10,000	2800
Elongation, percent at break point at 25° C.	......	......	......	325
Hardness, Brinell (550 lb. at 3 min.)	12–15	15–25	12–15	...
Hardness, Shore A	......	......	......	80
Impact strength (Izod) ft. lb.	.2–.6	.1–.7	.2–.6	...
Softening temperature, ° C.	60–65	65–75	60–65	[e]
Compressive strength, p.s.i.	10,000–12,000	......	10,000–12,000	...
Flexural strength, p.s.i.	12,000–14,000	......	12,000–14,000	...
Tendency to cold flow	Slight	Very slight	Slight	...
Machining qualities	Very good	[d]	Very good	...
With organic fillers	......	Excellent	......	...
With mineral fillers	......	Poor	......	...
Forming qualities, by:				
Swaging	Very good	......	Very good	...
Blowing	Fair	......	Fair	...
Spinning	Fair	[d]	Fair	...
Shearing	Excellent	Fair	Excellent	...
Abrasion resistance	Good	Good	Good	Good
Fatigue resistance	......	......	......	1,000,000 flexes
ELECTRICAL PROPERTIES:				
Dielectric constant at radio frequency	4.0	[d]	4.0	[f]
Electrical resistivity at 30° C. ohm per cm. cube	Less than 10^{14}	10^{11}	10^{14}	...
Breakdown voltage at 60 cycles, volts per mil	675	[d]	675	...
Power factor at 1000 cycles	.014	.02–.15	.014	...
Power factor at radio frequency	.018	.02–.06	.018	...
PHYSICOCHEMICAL PROPERTIES:				
Effect of aging (room temperature)	Unaffected	Unaffected	Unaffected	Slight Stiffening
Effect of sunlight		Darkens on prolonged exposure		Slight Darkening
Effect of ultraviolet light		Darkens on prolonged exposure		Slight Darkening
Effect of water (hot)	Softens	Softens	Softens	[g]
Effect of water (cold)	None	None	None	None
Water absorption, percent in 24 hr. at 25° C.	.05–.15	1.5–4.0	......	...
Water extraction, percent in 24 hr. at 25° C.	......	......	......	.20
Resistance to:				
Weak acids	Excellent	[d]	Excellent	[c]
Strong acids	Excellent	[d]	Excellent	[c]
Weak alkalies	Excellent	[d]	Excellent	[c]
Strong alkalies	Excellent	[d]	Excellent	[c]
Alcohols	Excellent	[d]	Excellent	[c]
Ketones	Dissolves	Dissolves	Dissolves	Dissolves
Esters	Dissolves	Dissolves	Dissolves	Dissolves
Aromatic hydrocarbons	Swells	Swells	Swells	Swells
Aliphatic hydrocarbons	Excellent	Good	Excellent	[c]
Mineral oils	Excellent	Good	Excellent	[c]
Animal oils	Excellent	Good	Excellent	[c]
Vegetable oils	Excellent	Good	Excellent	[c]

[a] Properties shown reflect characteristics of certain specific Tygon formulations. Physical, mechanical, electrical and corrosion-resistant properties may be varied by modification, or by use of use of other Tygon compounding materials.
[b] All constants in plasticized Tygon vary according to specific applications—data given is an average figure on a typical Tygon sheet.
[c] Flammability and chemical resistance of plasticized Tygon are dependent upon the type and amount of plasticizer used.
[d] Properties in these respects may vary greatly depending upon the composition, types and amounts of fillers.
[e] Softening temperature depends upon type and amount of plasticizer.
[f] Electrical properties depend upon choice of plasticizer and fillers.
[g] Heat (wet or dry), affects the stability of Tygon, depending upon the type and amount of stabilizer.

Heatronic molding

A new technique for rapid molding of thermosetting plastics makes possible larger molds and reduced molding pressures

by V. E. MEHARG*

HEATRONIC molding is announced as a most significant advance in the art of molding plastics. This process is the result of long and basic research involving the application of electronics to the molding of thermosetting materials, such as the phenolics and ureas. This new process appears capable of wide use, not only when applied to variations of present-day molding methods, but as the basis for still other methods. Unquestionably, it will also widen the field of application of thermosetting materials, opening up new uses and eventually affecting the entire economy of plastic production.

Early in the development of cycle molding of thermosetting plastics, it became evident that one of the most severe limitations of the process was the rate at which these materials, generally considered as insulators, could be heated to the molding temperature, particularly when molding thick sections. In spite of the many other advances in the art, this limitation has held to this time and, in fact, has become of relatively greater importance as the other factors affecting speed of molding have decreased. Heatronic molding strikes directly at this fundamental difficulty.

Recent trade publications have contained numerous references to the use of high-frequency electrostatic fields for heating wood and resin combinations to form bonded plywood. The usefulness of high frequency for this purpose is believed proved and without question. As applied to molding plastics, the results are even more striking and the field of application even broader. This process has, therefore, been studied in the laboratory and the principles for successful use determined.

It has long been known that many materials normally considered as electrical insulators will absorb energy and heat up when exposed to an electrostatic field of high frequency. This heating effect may be explained as resulting from "molecular friction" caused by the rapid alternations of the high-frequency field. The phenomena are somewhat comparable to hysteresis losses in magnetic materials when exposed to a changing magnetic field.

The rate of heating of a particular material in an electrostatic field is found to vary with the applied voltage, the frequency and the loss factor of the material. The relationship is expressed by the formula:

$$H = KfE''(E/t)^2$$

where H = the heat developed per unit volume, E = the voltage across the material, t = the thickness of the material, E'' = the loss factor, f = frequency of oscillating field and K = constant. Materials with an extremely low loss factor, such as polystyrene, show low heating effects at frequencies commercially available today. Most molding materials, however, have a relatively high loss factor and can readily be heated by present electrostatic methods. In fact, all the present-day large-scale thermosetting resins and their commonly used fillers are satisfactory in this respect.

For a given heating rate, an increase in the operating frequency results in a decrease in the voltage gradient across the heating condenser. As the possibility of arcing across the heating plates is a function of

Table I.—Loss Factor of Molding Material Preforms

	Megacycles 1	10	25	50
Phenolic woodflour filler	.130	.156	.161	.160
Phenolic asbestos filler	...	.351	.244	...
Urea cellulose filler	...	.123	.144	...

* Research and Development Laboratories, Bakelite Corp.

1—*High frequency heating equipment.* 2—*Condition of preform between electrostatic plates just prior to molding*

ALL PHOTOS, COURTESY BAKELITE CORP.

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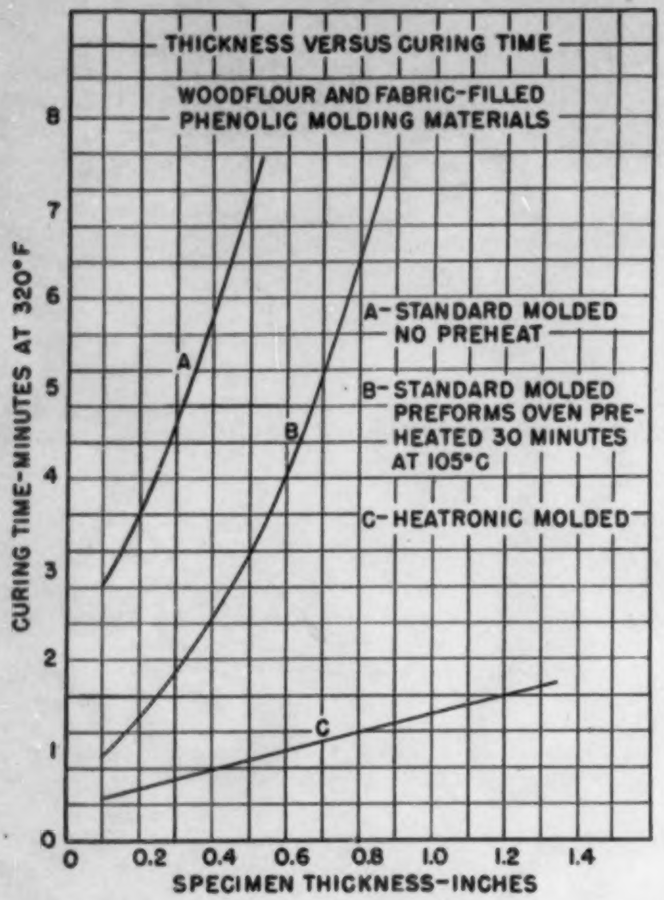

3—Optimum time of molding specimens of different thicknesses. 4—Effect of heatronic molding on plasticity of woodflour-filled phenolic molding material. 5—Effect of heatronic molding on plasticity of fabric-base phenolic molding material and cellulose-filled urea molding material. 6—Initial cost of radio frequency material and cost per kw. based on a number of installations made by different manufacturers. 7—Approximate tube cost, power cost and overall operating cost of radio frequency equipment versus the power delivered to the load. See discussion in text

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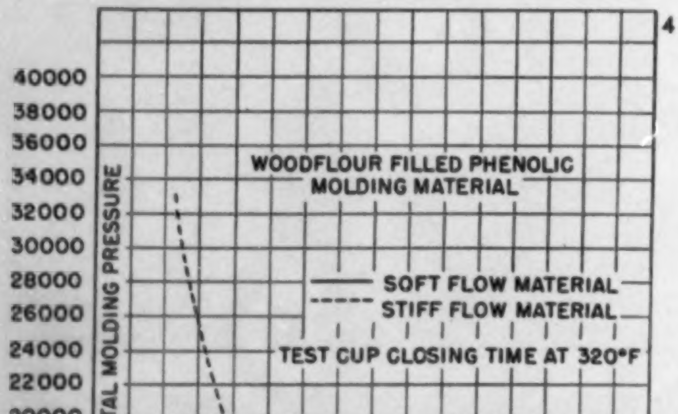

the voltage gradient, it is desirable to operate at the highest frequency commercially available. Table I shows the loss factor of several filled thermosetting molding materials in preformed state prior to molding. It will be noted that within the range covered there is no great change in loss factor with frequency. Thus there is wide latitude for choice of frequency and voltage to give the desired heating rate, and actual choice will be a compromise between availability, costs, operating characteristics and other factors of importance to the equipment manufacturers.

Of particular importance is the fact that when a preform of such a material is subjected to the high-frequency field, the heat is generated uniformly throughout the material, irrespective of size, and the rate at which this heat is developed is directly proportional to the power input. This means that the heat conductivity of molding materials, precluding size and weight as limiting factors, no longer has to be considered. Thus, theoretically, any quantity or weight of thermosetting molding material can be heated to molding temperature.

It is frequently believed that this method of heating depends upon, and is greatly affected by, moisture. This is untrue. It is actually undesirable to have a high-moisture content.

While many methods of adapting this technique to present-day molding are known, one of the most immediately useful applies to compression and transfer molding. The high-frequency equipment developed for this process is shown in Fig. 1. A simple and effective method consists in heating the preformed material to molding temperature in the electrostatic field set up outside the molding press, followed by quick transfer to the mold, or transfer pot, and rapid closing of the press to obtain flow prior to hardening. This transfer may be manual or automatic. Cycle controllers may be used to advantage. Other variations in order to secure maximum speed of operation will be evident. Thus the electrostatic heating field may be mounted over the mold and the heated material allowed to drop into the mold or be forced in by the mold plungers. In the case of a horizontal ram, the electrostatic heating plates may be mounted between the ram and the mold and use again made of the ram to force the heated material into the mold.

Although preforms are used in the foregoing procedure (see Fig. 2 for the condition of the preform between electrostatic plates just prior to molding), powder may also be heated if retained in a suitable container made of a superior insulating material of the ceramic type. However, it is easiest to obtain uniformity of heating if the material is of uniform shape, thickness and density, and this is readily obtained by use of conventional preforms. Furthermore, this uniformity of heating is particularly important for thermosetting materials sensitive to precure or overcure.

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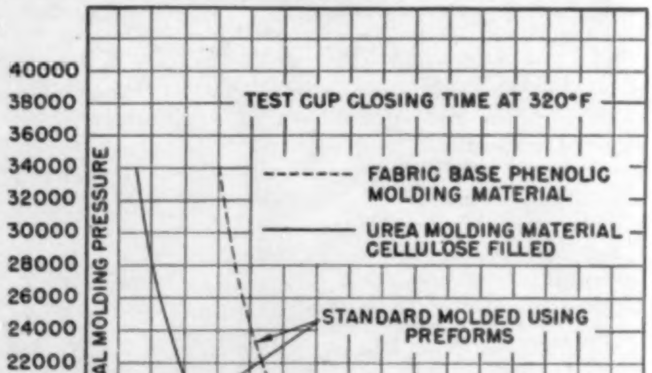

Table II.—Effect of Method of Heating on Flow Characteristics of Molding Materials

Type of phenolic molding material	Type molding	Total pressure	Mold closing
		lb.	sec.
General purpose	Standard	17,000 (minimum)	25
	Heatronic	17,000	6
	Standard	8,000	Not filled
	Heatronic	8,000 (minimum)	6
Improved impact-resistant	Standard	14,000 (minimum)	35
	Heatronic	14,000	4
	Standard	6,000	Not filled
	Heatronic	6,000 (minimum)	4
High impact-resistant	Standard	30,000 (minimum)	32
	Heatronic	30,000	11
	Standard	6,000	Not filled
	Heatronic	6,000 (minimum)	12
High heat-resistant	Standard	16,000 (minimum)	25
	Heatronic	16,000	13
	Standard	8,000	Not filled
	Heatronic	8,000 (minimum)	13

Heating of the material in the mold itself is also possible with a special mold construction in which the top and bottom plungers are used as the heating plates, and the chase is made of an insulating member having special electrical and heat-resisting properties. Such a mold has been used and may prove acceptable for many special purposes, although it imposes limitations likely to restrict its general use.

Under the preferred conditions, as outlined in the foregoing, the advantages of heatronic molding become outstanding. Some of the more important of these are discussed in the following paragraphs.

Molding time is decreased in all applications tried to date. This is true because *heat transfer* is an appreciable factor in practically all fast cycle molding. Naturally, the greatest advantage shows up as the thickness of molded section increases. Thus in Fig. 3 a graph is shown in which the optimum time of molding of specimens of different thickness is compared by the two methods. It will be noted that heatronic molding gives a rate of cure practically independent of thickness. The possibilities of producing thick sections, which are at present costly, time consuming and often impossible, are of the greatest practical importance in increasing the field and scope of thermosetting plastics, as well as eventually markedly lowering the cost of most present molded parts.

Plasticity or flow properties are greatly increased by heatronic molding. Some of these results are shown in Table II and Figs. 4 and 5 for various types of molding materials. This unexpected effect means that present-day moldings can be made at lower pressure. This insures a saving in press costs, either by permitting use of larger molds in available presses or use of smaller presses for the same molds. Experience shows that many materials can be molded at 25 to 30 percent of the pressures used today. In other instances, 40 to 50 percent of present pressures are necessary. If present-day pressures are used, harder flow materials may be molded.

Lower molding pressures lead not only to immediate savings in press costs, but also to other equally if not more important advantages. Thus the wear on molds should be much less than at present. The problems in connection with insert shearing and displacement are greatly relieved. It also seems likely that many low-cost methods of producing molds which have been adopted in other related fields may now find use in the molding of thermosetting materials. This further reduction of mold and other costs should enable the plastics industry to reach many users, especially those needing only small quantities of molded parts, and thus further expand the use of plastics. Another point of great potential significance lies in the opening of the field of large moldings. This refers not only to those of thick cross section, but also to those of large area. In lowering the molding pressure and decreasing time of cure, the greatest obstacles to large parts are re-

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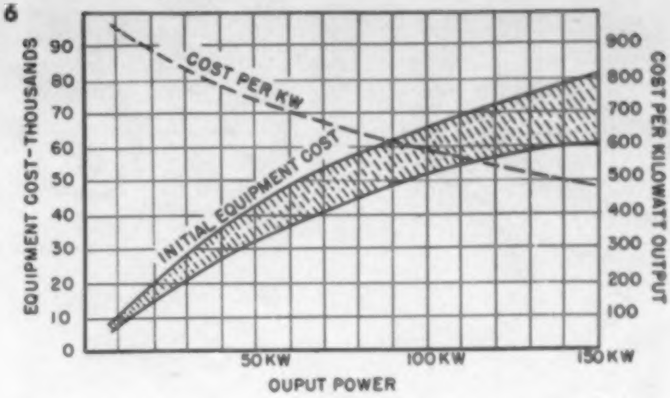

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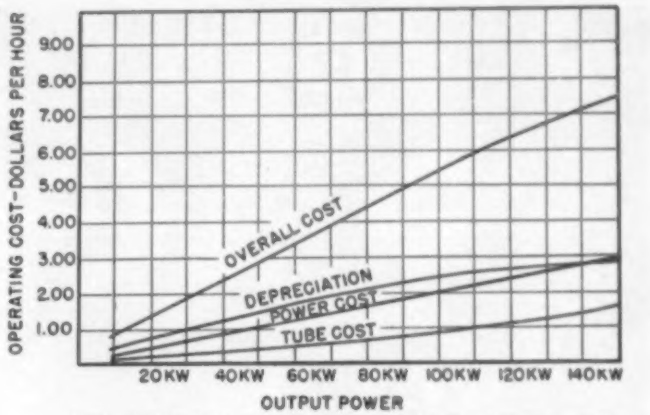

COURTESY OF JOHN P. TAYLOR, VICTOR DIV., RADIO CORP. OF AMERICA. REPRODUCED BY PERMISSION OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Table III.—Physical and Electrical Properties of High Impact-Resistant Phenolic Material (BM-3510 Black) Molded by Standard and Heatronic Methods[a]

	Heatronic molded		Standard molded	
	Cure time at 320° F.	Test Value	Cure time at 320° F.	Test value
Tensile strength, p.s.i.				
Condition I	$1^1/_4$ min.	7,600	12 min.	7,440
Condition II	$1^1/_4$ min.	7,840	12 min.	7,050
Impact strength, Condition II, ft./lb. per in. of notch	$1^1/_4$ min.	2.9	12 min.	3.0
Flexural strength, Condition II, p.s.i.	$^1/_4$ min.	15,270	12 min.	12,900
Compressive strength, Condition II, p.s.i.				
Parallel to molding pressure	$1^1/_4$ min.	23,900	12 min.	34,400
Transverse to molding pressure	$1^1/_4$ min.	27,170	12 min.	25,060
Insulation resistance (4-in. disk by $^1/_8$ in. thick), megohms				
Condition III	$1^1/_2$ min.	5,000 —	30 min.	5,000 —
Condition II	$1^1/_2$ min.	6.3	30 min.	6.6
Dielectric strength (4-in. disk by $^1/_8$ in. thick), Condition II, volts per mil	1 min.	S/T 144 S/S 72	12 min.	S/T 157 S/S 92
Dielectric strength (4-in. disk by $^1/_2$ in. thick), kilovolts				
Condition III	$1^1/_2$ min.	20 —	30 min.	20 —
Condition II	$1^1/_2$ min.	6.8	30 min.	5

[a] Condition I—As molded. Condition II—After 48 hr. immersion in water at 50° C. Condition III—After 96 hr. at 70 percent relative humidity at room temperature.

S/T—Short-time test. S/S—Step-by-step test.

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8—Test cups molded of general-purpose phenolic material. Total pressure, 8000 lb. Left, standard molded, cup not filled; right, heatronic molded, 6 sec. close. **9**—*Test cups molded of high impact-resistant phenolic material. Total pressure, 16,000 lb. Left, standard molded, cup not filled; Right, heatronic molded, 14 sec. close.* **10**—*Cross section of disks 3 in. diameter, $^1/_8$ in. thick. Molded of high impact-resistant phenolic material at 320° F; left, standard molded, preheated for 30 min. at 10 min. cure, 220° F.; right, heatronic molded, $1^1/_2$ min. cure.* **11**—*Telephone handset molded by heatronic method in 30 sec.; standard method is from 3–5 minutes*

moved. Fortunately also, electronic equipment of such size is available to permit immediate production of moldings up to 50 pounds.

In addition, the above advantages are obtained along with *improved molded properties*. It will be noted from Table III that not only have strength and electrical values been retained, but time of cure has been greatly decreased in all instances. It should also be emphasized that this decrease in cure time is obtained without sacrifice of thoroughness of cure as shown by acetone extractives. Not only do the conventional tensile and flexural strength values show an increase, but there is also good evidence that the molded pieces are stronger because of less internal strains. This is especially noticeable in parts of thick sections, and those containing sections differing widely in thickness. This leads to better uniformity and more dependable strength values in molded parts. In the final analysis, this last may prove to be the most important of all the advantages. As an explanation of these improved properties, it should be noted that proper heatronic molding requires uniform heating of the material prior to plastic flow and completion of flow prior to hardening. This provides a uniformity in the molded piece not obtained by present molding processes. For many materials improvement is also found in water resistance and electrical properties.

The economics of heatronic molding have been pointed out with regard to savings in press, mold and labor costs. The cost of the electronic equipment and its effect on overall cost remain to be discussed. The curves in Figs. 6 and 7, prepared by the Victor Div., Radio Corp. of America, give much valuable information. Experience has shown that the actual current cost per pound of material heated is approximately $^1/_{10}$ of a cent. The curves represent approximations on the basis of a few installations and will vary somewhat with different manufacturers. This particularly refers to the equipment cost. In other words, the data should be considered only as a rough estimate. Generally, such operating costs assume 5000 hours' tube life and power at 1 cent per kwh.

In giving the above data, equipment manufacturers offer hope of improvements in many respects which will be available after the present emergency. Initial costs and tube replacement should be the main items and, in practice, the latter has been shown to be small. The main cost, therefore, is for the initial equipment. No analysis of the effects of this on cost of the finished article can be made except for a given mold and given set of operating conditions.

One point often missed in first consideration of this process is that heating of the molding material does not have to be done while the press is idle. In other words, the molding and heating can be synchronized to give a minimum cycle. Furthermore, it has been found that a central high-frequency heating unit may be used to supply energy for a number of molding presses. It is only necessary that the total power does not exceed the rated capacity of the generator.

Molds which have a large number of inserts and which, therefore, require a considerable time for placing these inserts demand special study, but it is believed that a short cycle can usually be obtained by providing duplicate parts of the die which holds the inserts—the disassembly and assembly of these being a bench operation which will not hold up the molding cycle. Such a technique, already common in many molding plants, will be further emphasized.

It can be seen that the advantages of heatronic molding are as follows:

1. Molding of thermosetting impact-resistant phenolic materials, when preformed, can be accomplished as readily as the molding of general-purpose wood-filled phenolic materials. This should widely increase the use of the impact-resistant materials.

2. Molding of thermosetting materials in $^1/_8$ in. thickness and greater can be accomplished in cycles as short or shorter than the cycles for thermoplastic materials on injection molding machines.

3. Molding pressures may be reduced by 30 to 40 percent as compared to those necessary for the present methods of molding.

4. Curing time may be shortened to from $^1/_{10}$ to $^1/_2$ the time used in present methods of molding.

5. For the first time it becomes commercially practical to mold pieces thicker than $^3/_8$ of an inch from thermosetting materials.

Acknowledgment

The author gratefully acknowledges the great assistance and aid in this work given by C. M. Chase of the Manufacturing Department, and F. M. Rugg, A. P. Mazzucchelli, and R. E. Nicolson of the Research and Development Laboratories, Bakelite Corp.

Paper laminates for molding

by HAROLD J. LUTH*

IT is pretty generally known that in the early part of 1942 there was considerable apprehension as to the possibility of supplying sufficient aluminum to satisfy the needs of the aircraft industry. A great deal of pressure was brought to bear on aircraft designers to substitute, either in wood or paper-laminated plastics. The Director of Research and Engineering of the Brunswick-Balke-Collender Co. was called upon to visit the engineering departments of many of the aircraft corporations, particularly those on the West Coast. During these visits, a great deal of interest was evidenced in the substitution of other materials for non-stressed and secondary structural parts then being made from aluminum alloys.

Generally speaking, it was difficult for custom molders to become interested in aircraft parts, primarily because of the relatively small volume of each part. The cost of dies pro-rated over the average run of aircraft parts generally was prohibitive. The Brunswick-Balke-Collender Co., not being a custom molder, and having been interested in the past only in molded and plastic parts for their own equipment, had always had to face a similar problem, inasmuch as large production runs for parts of their own products were exceptional rather than the rule.

Hence, this company had had considerable experience in the making of low-cost and temporary molds, using alloys instead of steel, or a material such as silicon bronze. For the low-pressure work, they had in the past largely used lead antimony alloys; but in order to make parts which could be substituted for aluminum alloy parts in aircraft, they deemed it necessary to go to higher pressure materials which would require high tensile alloys for molds.

For these particular parts Kirksite, a zinc alloy, was selected because of its uniform shrinkage, relatively high tensile values and the excellent castings obtained from it, which required little or no cleaning up. Although such alloys are, generally speaking, unsatisfactory for large production runs, the molds made by this company would outlast the run of the particular parts being made.

In the case of molds in which considerable side pressure was involved, the zinc alloy was supplemented by steel banding to prevent the mold's distortion under hydraulic pressure. The material selected for molding the parts was Brunsalloy AC, which is a phenolic resin-impregnated paper laminate. For formed secondary structural parts it could be substituted generally with no redesign—or in some cases with slight redesign—and be eminently suitable for the application. For this particular type of formed work, a crêped paper-base material impregnated with general purpose phenolic was used.

This can be used in secondary parts where extremely high strength values are not too important. Where it is necessary to have higher tensile values, a long-fiber paper-base material is required, using low pressure, high tensile laminating resins. With the general purpose impregnating resin, articles molded at 1200 p.s.i., with a tensile strength on the order of 8000 p.s.i. are obtained. Increasing the molding pressure to about 2000 p.s.i. will increase the tensile strength to about 13,000 p.s.i.

In the early stages of the substitution of phenolic laminates for aluminum, there was considerable apprehension about the effects of temperature. Working with the Armour Research Foundation, some data were obtained on flat panels molded of crêpe-base material, using a general purpose phenolic resin.

The following tabulation is a summary of the results obtained:

	Room temperature	*140° F.*	*−60° F.*
Tensile strength, p.s.i.	8,717	8,056	11,300
Compression strength, p.s.i.	40,000	35,333	36,200
Modulus of rupture in bending, p.s.i.	14,600	15,700	
Impact strength, ft./lb. per in. (edgewise)	.788	1.010	.640
Impact strength, ft./lb. per in. (flatwise)	1.510	1.650	.950

Elongation, %	3.3
Modulus of elasticity, p.s.i.	700,000
Hardness, Rockwell	M-95
Coefficient of expansion per ° C. −50° to +40° F.	.000018
Water absorption, 24 hr., % (A.S.T.M.)	1.0-2.0

It was particularly gratifying to know that at low temperatures the physical properties with regard to tensile and compression strength were improved, and the impact values only slightly deteriorated. Taking into consideration the expected experimental error, the test results were quite consistent.

Sheets molded from this material preserve their physical values throughout the structure, as the laminae are preserved unbroken throughout the cross section of the piece. (*Please turn to page 138*)

* Director of Research and Engineering, Brunswick-Balke-Collender Co.

1—*Lengths of tubing made of the interlaminated birch and paper material.* 2—*Paper-base material impregnated with phenolic resin is compressed with plywood and metal into strong, lightweight assemblies*

PHOTOS, COURTESY BRUNSWICK-BALKE-COLLENDER CO.

1

2

Design for tomorrow

TODAY the war is, as it should be, our first and paramount consideration, and it will continue to be until it is won. Whether this takes one year or three years or five years, the United Nations will eventually be victorious and the world will again be at peace. Until that time every nation, every citizen and every business organization must at no time forget the purpose of its all-out war effort—to make this world a better place to live in.

However, when the war is over, we shall not be taking the family for a Sunday drive in a tank or a jeep. Neither shall we be living in tents nor making our permanent homes in trailers. Millions of people will rush forth to buy the long-wanted new car or home or to replace the worn-out washing machine and vacuum cleaner. In order to expedite this change from a necessarily uncomfortable wartime existence to comfortable peacetime living, American industry will be called upon to make a swift transition from the manufacture of guns, tanks and ammunition to the manufacture of cars, washing machines and all the other appliances which have made our civilization what it was a few years ago. In order to make this conversion, industry must be prepared. Its plans must be laid and its policies formulated so that after peace is declared, all manufacturing will resume producing its peacetime goods with as little lag as possible.

This changeover will not be so simple as it might seem at first glance. During the past three years new materials, new methods and new processes have been developed which will cause material changes in many industries. The growth of the plastics industry will be the cause of a great number of these changes. Most of the major discoveries in plastics have either been confined in the laboratories where they were made or adopted on a very small scale in war matériel, due mainly to the strategic nature of the components and to the fact that these components were needed for the manufacture of such things as amatol, smokeless powder and synthetic rubber or rubber substitutes. With the war's end, however, these necessary restrictions will be removed and the new plastic compounds will go into high gear for peacetime production.

In the great conversion and substitution program which was initiated in order to conserve such materials as steel, aluminum, bronze and magnesium, plastics were called upon for purely replacement substitutions. But much to the surprise of even the plastics industry, a large number of these substitutions appear to be doing a far better job than the materials which they displaced. This fact alone proves that plastics are no longer a secondary material, but have taken their place as one of the major materials, equally as important as metals.

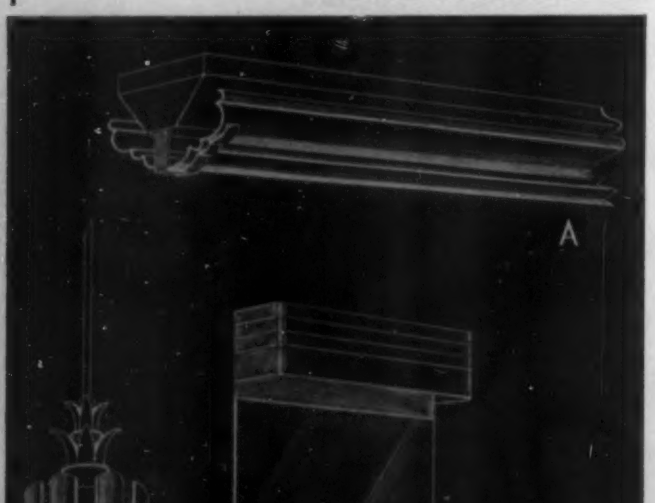
American industry cannot afford to wait for peace to educate itself with regard to the uses and methods of handling these new materials. It is true that many industries have postwar planning departments at present, but for every one of those that are looking into the future there are probably a hundred that are giving no thought to these important plans.

With this in mind, MODERN PLASTICS called upon Frederick E. Greene, industrial designer, of Westport, Conn., to formulate some constructive, workable applications for plastics. His first efforts were confined to the lighting and house hardware field, some applications of which are illustrated herewith.

1—Some suggested applications of plastic materials to the home lighting field. 2—A two-light overhead fixture combines three extruded strips of plastic material with integral interlocking devices. 3—A cut-away section of B in Fig. 1 shows construction of the circular extruded thermoplastic reflector

ALL PHOTOS, COURTESY FREDERICK E. GREENE

1



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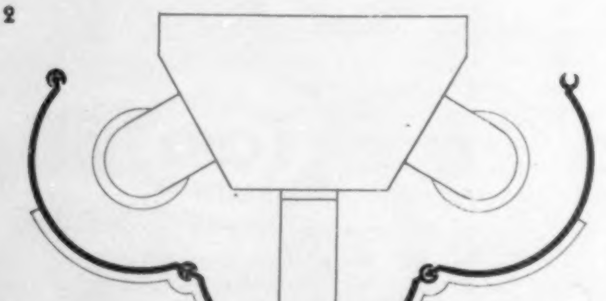

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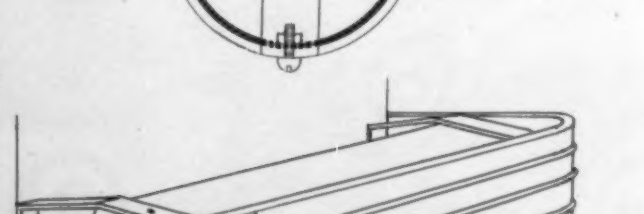

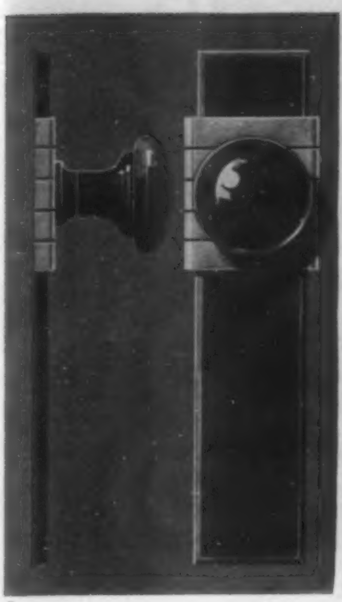
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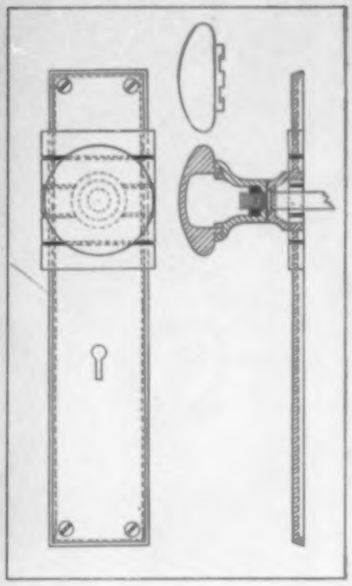
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Figure 1 shows several possible applications in the home lighting field. Inasmuch as fluorescent lighting has made such great strides in the industrial field, it is a well-known fact that when materials again become available, this type of lighting will make equal strides in the illumination of homes.

Mr. Greene has used extruded transparent or translucent thermoplastic strips in various forms. One method of construction of a two-light overhead fixture is shown in Fig. 2, Fixture A. This makes use of three similar extruded strips with interlocking devices extruded integral with each strip. The stock is cut into the necessary lengths and assembled lengthwise as shown in the drawing.

Fixture B in Fig. 1 makes use of four extruded sections of varying widths for purposes of design. These parts are assembled in the same manner and are formed into shape on a cheap wooden forming die, the material being heated in an oven previous to forming. Figure 3 shows this fixture in a cutaway section and reveals a circular extruded thermoplastic reflector. The color of this reflector can be an opaque white which would give a maximum of light reflection.

Fixture C in Fig. 1 shows the designer's idea of an overhead fixture of the future. On this overhead fixture there are several parts which can easily be molded from either thermosetting or thermoplastic materials.

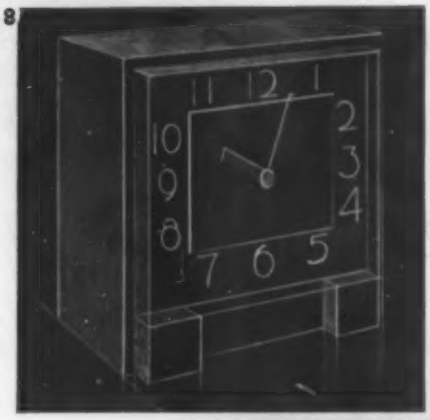
Fixture D, Fig. 1, makes good use of an extruded section for bathroom sidelights. All of these fixtures incorporate standard fluorescent bulbs and standard extruded thermoplastic material which would be available at present if it were not for our all-out war effort.

Turning to the home hardware field, our designer has given us several different approaches (Figs. 4–6), any one of which can easily be manufactured by the use of either thermosetting or thermoplastic materials. Some of the escutcheons would, from necessity, have to be molded while others, after a slight fabrication effort, could be manufactured through the use of extruded sections.

The working drawing (Fig. 7) shows the general construction, which can be incorporated in any of the designs shown. It will be noted that the knob will be molded in two parts, that the top and bottom will be glued together by the use of one of the solvents for the materials, and that any turning action will be stopped due to the gear tooth construction. Before assembling the two halves of the knob together, a standard nut will be forced into a molded depression in the shank half of the knob. A hole will be drilled through the plastic and nut, and this hole tapped for a standard size set screw. Thus the two halves of the knob will be permanently assembled. This is a standard hardware construction and the assembly of the knob and escutcheon will be done in the usual manner.

Figures 8 and 9 show two proposed plastic clock cases which can be manufactured in various ways. Both designs will permit the entire face to be of clear transparent plastic with the numerals molded integral with the face. These faces can then be assembled either to a metal or to a plastic case. Another possible means of molding these designs would be to mold the entire case and face with the exception of a small opening to make the hands visible. This method would probably make use of opaque thermosetting materials but would also have the numerals molded. A piece of glass or clear thermoplastic sheet could then be assembled into the small opening.

8



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4–6—*A group of door knobs and escutcheons which incorporate either thermosetting or thermoplastic materials. Some of these items are molded, while others make use of extruded sections and require slight fabrication.* **7**—*General construction of any of the three home hardware designs. Knob molded in two sections and cemented is permanently assembled by standard nut and screw.* **8, 9**—*Plastic clocks whose entire faces are of clear, transparent material. Numbers are molded integral with the faces. Cases are metal or plastics*

Control sheaves for continuous take-ups

As all insulation of electrical wire and cable is accomplished at high speed, it is necessary that some method of continuous-tension reeling of the product be available. In order to be universal as to application, this equipment must have complete speed control as well as a wide variation in tension take-up. A complete unit to accomplish this purpose has been engineered by the Watson Machine Co. and has been widely employed by insulated-wire manufacturers. This unit, until recently, has been equipped with accurately machined ball-bearing magnesium and aluminum alloy sheaves (Fig. 1), which had to meet the following requirements:

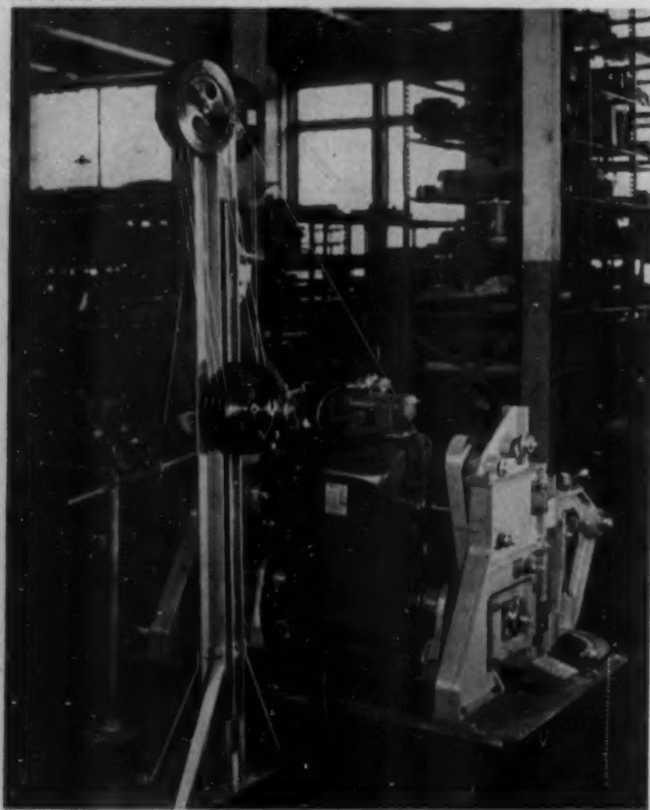
1. Accuracy and interchangeability with equipment already in the field.
2. Light weight to minimize inertia effects and permit tensions as low as 2 lb. for very light wire.

In order to eliminate the use of as much critical and expensive strategic metal as possible, this machine company has for some time been investigating substitutes which would meet the critical requirements of this equipment. An attempt was made to secure a suitable pressed steel (sheet metal) sheave, but all efforts along this line led to unsatisfactory operation. A plastics molder was then given the problem of designing a satisfactory molded sheave which would meet the principal minimum requirements of the equipment. Particular stress was laid upon a suitable ball-bearing fit and nearly perfect concentricity of the groove with the ball-bearing center. Both the machine company and the molder decided that a satisfactory sheave could be molded from a woodflour phenolic, and if the strength were not sufficient a medium or high impact material would definitely solve all problems.

As can be seen from Figs. 2 and 3, there was very little design difference between the metal and plastic sheave except that in the latter round holes were substituted for spokes, permitting the construction of a less costly and more simple mold.

In order to mold the groove, it was of course necessary to design a split mold, and for speed in molding and ease in handling, it was decided to use three splits instead of two. This made the split removal from the molded piece easier, and reassembly into the chase was accomplished in a minimum of time. The mold layout is shown in Fig. 4, and the automatic method of knocking- (*Please turn to page 148*)

PHOTO, COURTESY WATSON MACHINE CO.



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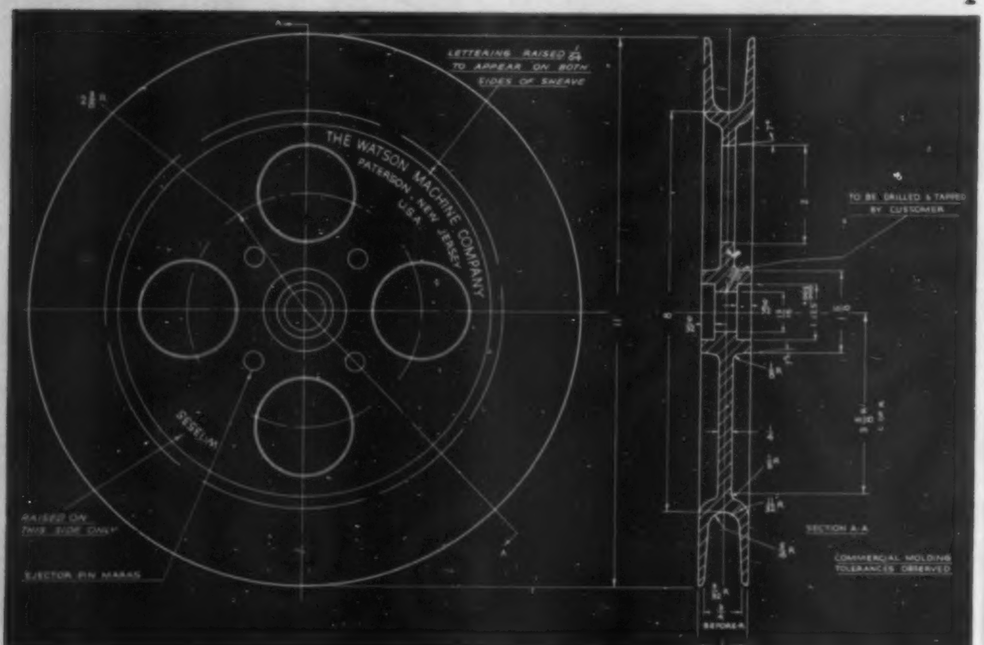

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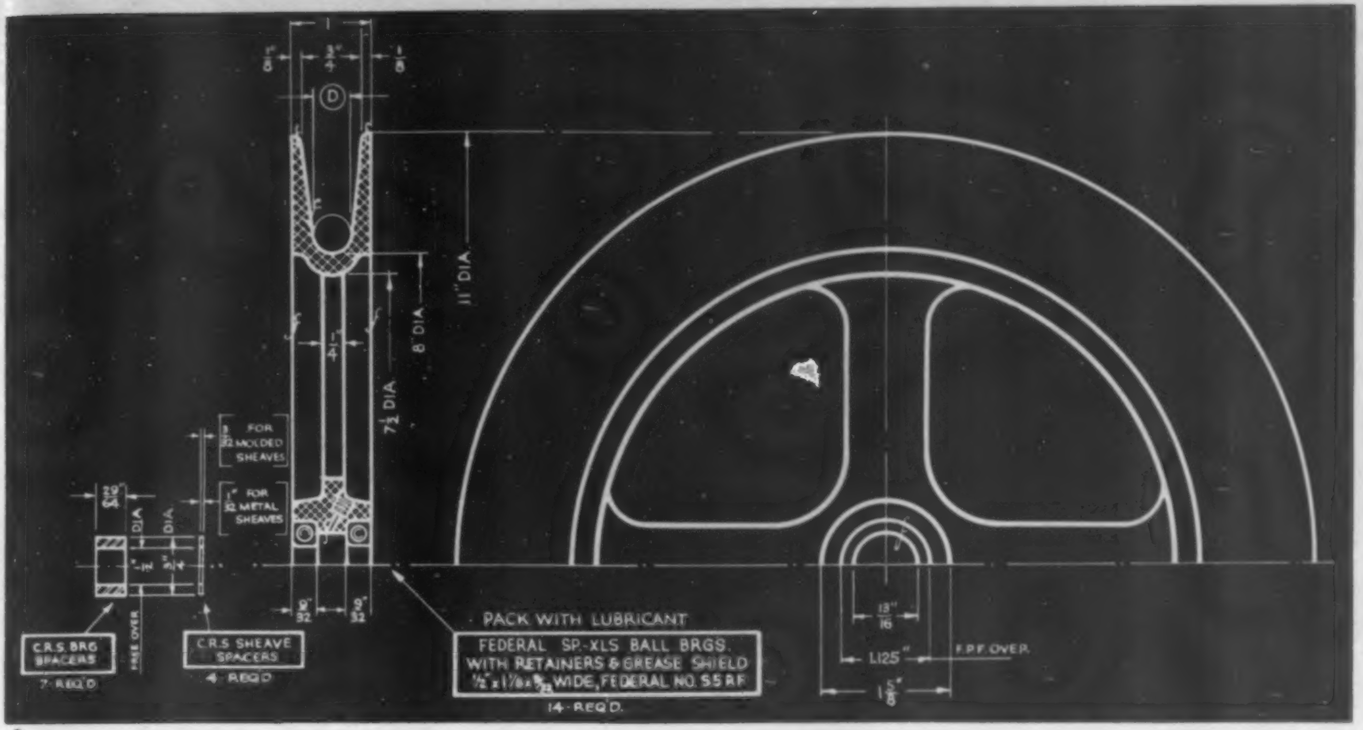
1—Continuous take-up for electrical wire and cable. Six plastics sheaves are standard equipment on this machine. 2—Design approved for production of plastic sheaves



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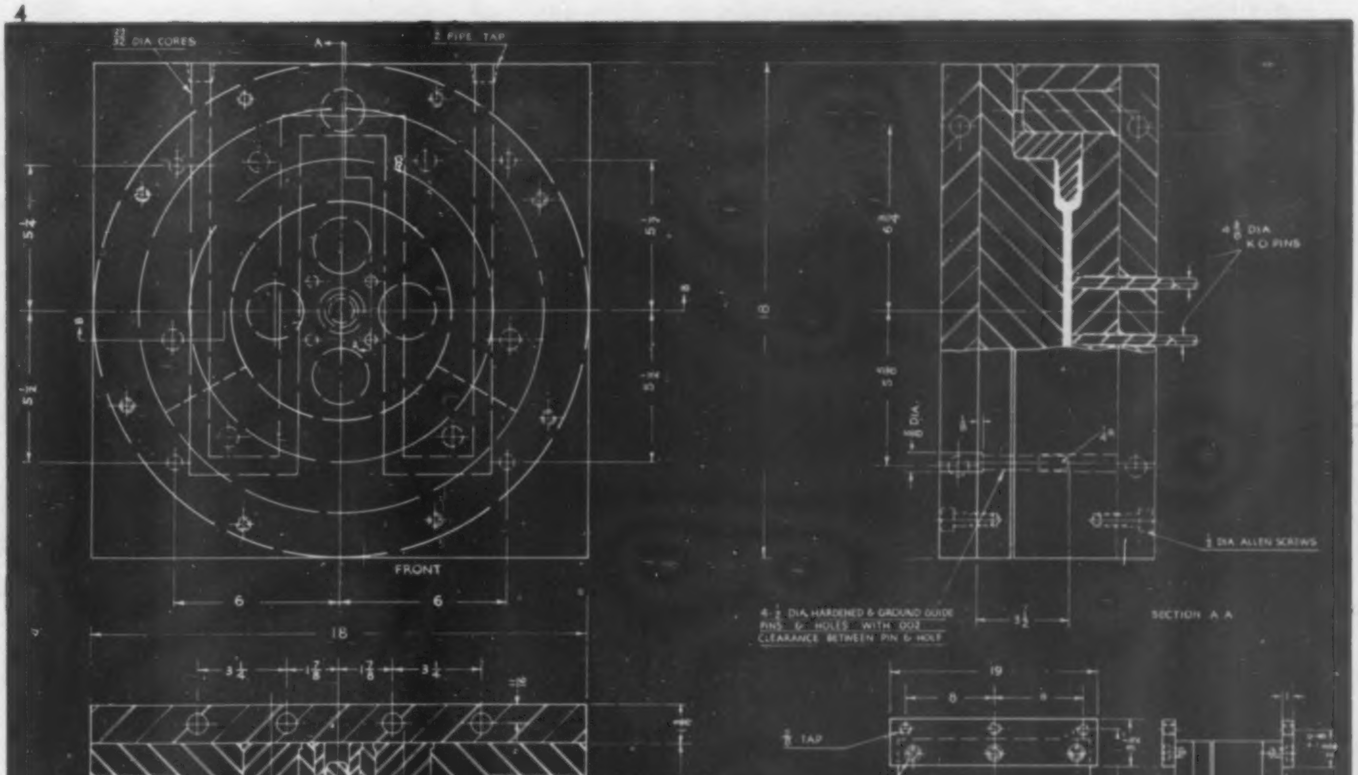
3—*Aluminum sheave which was converted to phenolic plastic*

4—*Drawing of single-cavity mold layout for the plastic sheave*

4



Steps for prolonging instrument life

by THEODORE A. COHEN*

INSTRUMENTS have in recent years found many and unusual applications in all industries. They are being applied to reduce labor costs and manufacturing processes, to lower fuel costs through exact control, to speed production and to improve product quality and eliminate spoilage or rejects.

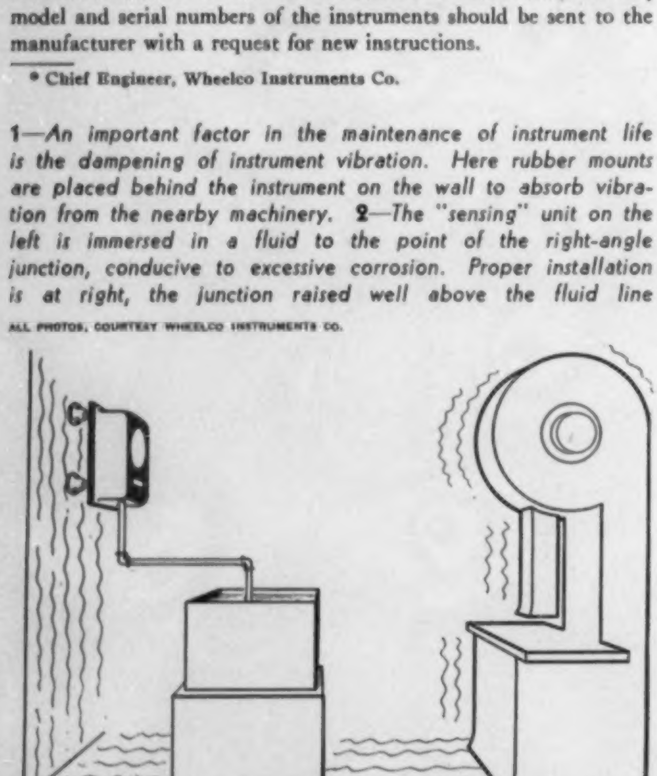
Continued enjoyment of these benefits is dependent, to a large degree, upon proper care of instruments now installed, whether they are doing 24-hour service in war plants, or normal service in civilian industries. Shortages of critical materials are necessitating substitutions in components of many instruments, while heavy demands upon manufacturers are slowing delivery of certain types regardless of the priority commanded by the purchaser. Needs of war industries make delivery of instruments to many other companies wishing them impossible.

Steps that can be taken to prolong the life of industrial instruments, regardless of manufacture, are outlined in this article. This information should be supplemented by careful study of instructions furnished by the manufacturer of each instrument to make sure the equipment is installed and operated according to the manufacturer's recommendations. If such instructions have been mislaid or lost, model and serial numbers of the instruments should be sent to the manufacturer with a request for new instructions.

* Chief Engineer, Wheelco Instruments Co.

1—An important factor in the maintenance of instrument life is the dampening of instrument vibration. Here rubber mounts are placed behind the instrument on the wall to absorb vibration from the nearby machinery. 2—The "sensing" unit on the left is immersed in a fluid to the point of the right-angle junction, conducive to excessive corrosion. Proper installation is at right, the junction raised well above the fluid line

ALL PHOTOS, COURTESY WHEELCO INSTRUMENTS CO.



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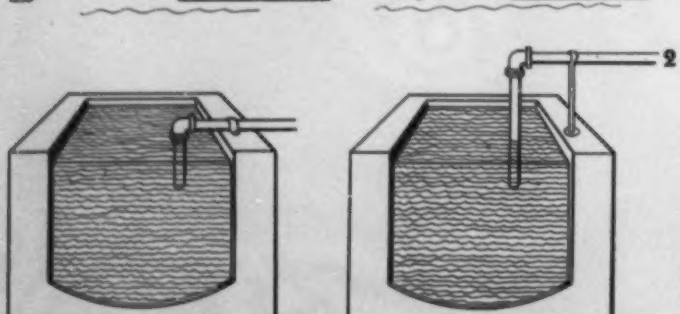

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Centralize responsibility

All instruments in a plant should be the responsibility of one man, or a group of men, depending upon the number of instruments used. Responsibility for instrument care and maintenance should not be left to the men operating the equipment on which they are installed, as this practice will result in complete lack of maintenance until instrument breakdown, or in unnecessary or harmful tampering by individuals unfamiliar with instrument operation.

Locate properly

Improper location and improper installation of industrial instruments probably cause more trouble and inaccuracy than fault or failure in the instruments themselves. It is as important that instruments be installed where they can be properly serviced and protected as it is to install them where the bulb, thermocouple, photoelectric cell, radiation head or other "sensing" unit can reach the temperature, pressure, vacuum or other condition the instrument is to measure.

Eliminate vibration

Prolonged vibration, or shock resulting from careless handling are chief causes of instrument failure. Installing instruments on vibration mounts will minimize the effects of vibration. A better method is to mount instruments in locations where vibration is not present. Instruments should not be mounted upon moving equipment. If instrument panels also carry contactors, these contactors should be removed so that the shock to the instruments resulting from contactor operation is avoided.

Pivots and bearings, particularly of pyrometric instruments, will cause trouble from misalignment or deterioration if the instrument is subjected to sudden shock or persistent vibration. A sudden jar or jolt may crack a jewel bearing or cause the pivot to jump out of its bearing, while repeated vibration will dull pivots and reduce an instrument's sensitivity.

A prime example of the above would be the mounting of a pressure gage or similar instrument near preforming equipment or punch press equipment without first eliminating the vibration by the use of rubber mountings or other vibration damping materials.

Protect from dirt

Next to excessive vibration, infiltration of dirt probably causes most industrial instrument trouble. Where instrument movements are particularly sensitive to foreign material that might affect their operation, they usually are provided with dust-proof cases. Such instruments should be opened as infrequently as possible, and then preferably in the instrument shop or in a room where provision can be made to keep parts clean. The slightest particle of dust or lint caught in the air gap of a millivoltmeter pyrometer, for example, can obstruct the free movement of the coil, while a metallic particle adhering to the pole pieces of the permanent magnet can stop functioning of the instrument completely.

Wherever thermosetting materials are being mixed, rolled or preformed, there will be an excessive amount of dust present in the air, even though a suitable dust exhaust system is installed. In the majority of molding rooms there will also be this danger of dirt infiltration due to the facility with which the dust from the thermosetting materials becomes suspended in the air.

Corrosion hazards

Any instrument, regardless of its function, will be impaired if placed in a corrosive atmosphere. Corrosive fumes attack instrument finish, moving parts, measuring systems, and may directly result in measuring error and impaired or erratic performance. Special

corrosion-proof cases are available for most instruments, but even they do not give absolute protection when the necessity of opening case doors for chart changes on recording instruments, and adjustments to other instruments, is considered. A small compressed air line connected to the case, with an escape provided through a small breather hole in the case, will properly ventilate the case and provide a slightly excess pressure within it to keep out room atmosphere at all times.

Corrosive fumes will also attack bulbs, bulb sockets, connecting tubes between bulbs and instruments, thermocouples and lead wire. Painting bulbs and bulb sockets with corrosion-resistant paint will prolong their life. A badly corroded bulb socket should be replaced to prevent its complete failure and resultant damage to the bulb.

It is well known that certain molding compounds, such as saran, for instance, give off very corrosive fumes. These fumes have been known to rust the surface of molds which have been stored in the vicinity of molding equipment which is handling this material. It would be wise, therefore, for all molders to check whatever material they have or anticipate using as to the corrosive action which may be inherent in this particular material. Saran is mentioned only as an illustration.

Avoid excessive temperatures

The majority of molding equipment, including compression, injection, transfer and extrusion, have either automatic heat controls or temperature recording instruments. In self-contained units, these instruments are sometimes mounted directly on the equipment and therefore are in danger of excessive temperatures, either from the direct heat transfer through the equipment or from the heat waves emanating from the heating elements and heated platens.

For best results, excessive temperatures, both high and low, must be avoided at the point where the instrument is installed. An instrument is built to give best operation at room temperature, approximately 70° F., and prolonged use at extreme temperatures will affect the instrument's accuracy.

All instruments are subject to error in measurement if exposed to large changes in room temperature, since exact compensation for such changes, over large ranges, is uncommon. It is best to mount instruments in locations where minimum temperature changes will occur at the instrument. Instruments should not be subjected to ambient temperature changes larger than 80° F.; for example, from 40° to 120° F. It is preferable, however, to keep the temperature at the instrument as close to 70° F. as possible.

Tubing and lead wires

If protection tubing for capillaries of filled-system instruments is damaged, wind with tape to prevent further deterioration. Carefully remove any sharp kinks in the tubing. If tubing or lead wires run near the floor, build a housing over them or fasten them securely to some solid object where they will not interfere with or be disturbed by passing traffic. In the absence of metal conduits for protecting capillary tubing between bulb and instrument, wooden strips can be employed to give the same protection.

Lead wires from thermocouples or pyrometers, or sending elements of other instruments, should be located so they will not be snagged by workmen, passing trucks or cranes. Examine insulation regularly and take steps to prevent its abrasion. Worn or cracked insulation can be taped, and connections should be checked to make sure they are tight. Locate lead wires away from flames, hot gases, hot pipes and water or oil drips.

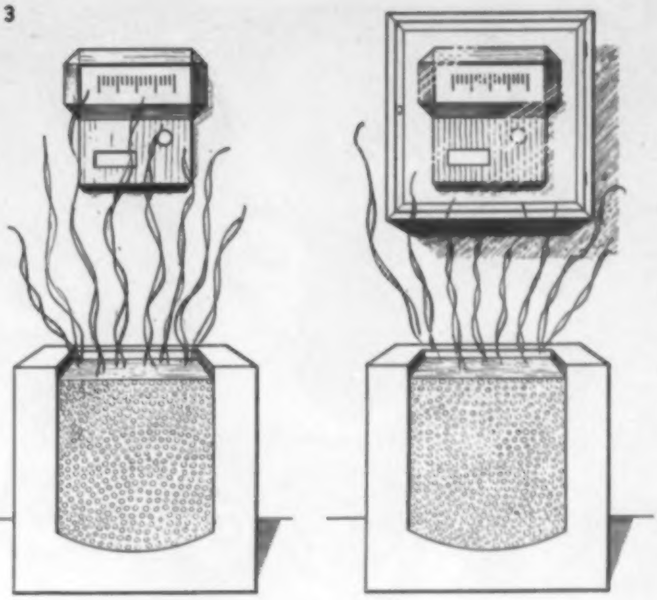
Avoid excessive moisture

Excessive moisture will often harm industrial instruments. For installations where moisture cannot be avoided, a protecting case is recommended.

Do not expose instruments to strong magnetic fields. When installing or relocating instruments, make sure all connections have been made exactly as specified in the instructions. All connections must be tight and free from dirt and moisture. Clean contacts and terminals often.

Charts for recording instruments should be stored in a cool dry place. Keep charts flat, preferably in their original package, until used. When recording instruments are out of service for any length of time, shut off power to the instrument and remove ink from pens.

3



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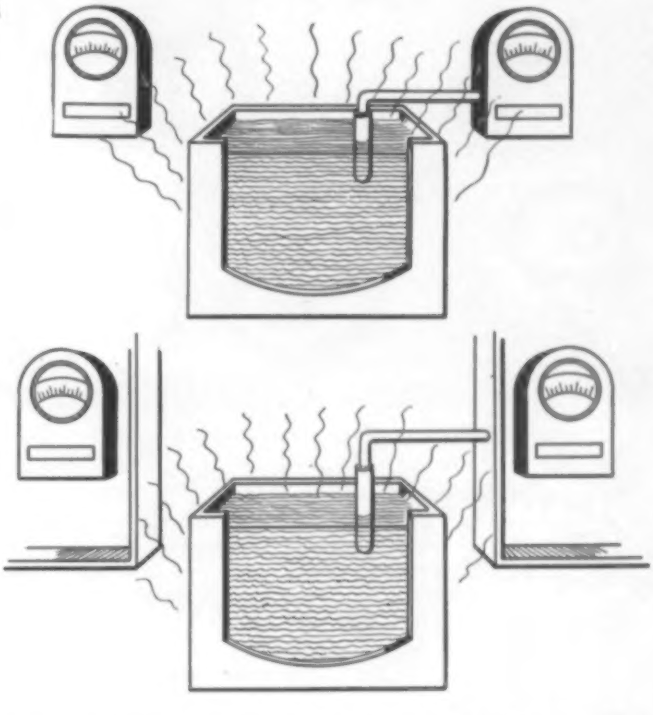


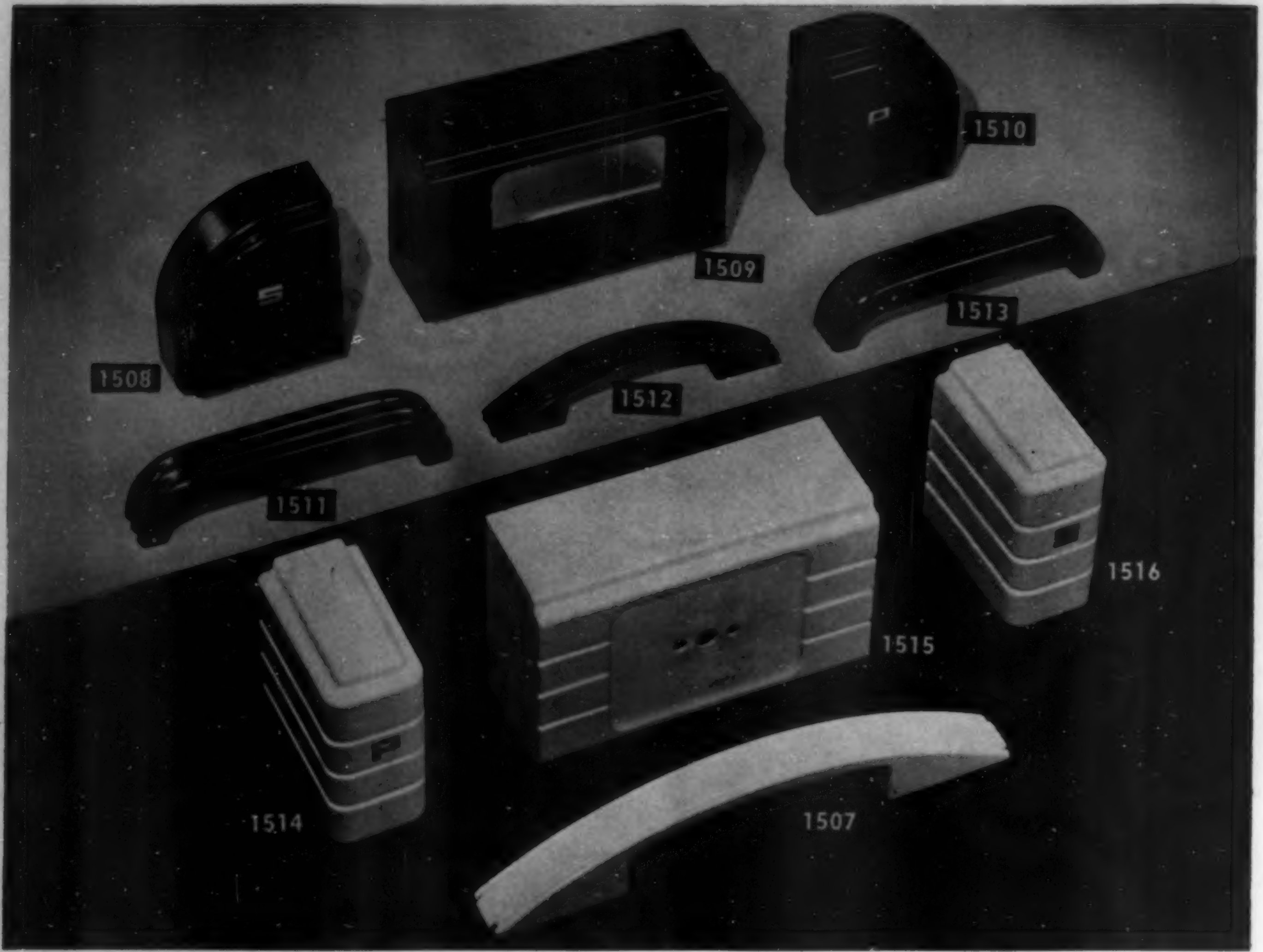
3—The instrument at the left is exposed to heat radiation from a furnace, endangering its accuracy and life. At right, an insulating shield over the equipment provides adequate protection. 4—Exposure to a corrosive atmosphere interferes with normal performance of the unprotected instrument at the top. Below, a vapor-tight case keeps out the corrosive fumes

Pressure instruments

Pressure instruments frequently require special attention, as their vital measuring elements usually are exposed to the material undergoing pressure treatment. This material usually fills the measuring system, and may cause trouble if the installation is not correct.

Protection of measuring element

The material being processed may seriously corrode the element, may solidify in the measuring system at the ambient temperature, or it may deposit heavy tars which would clog the measuring element. Protection from these conditions may be *(Please turn to page 142)*



Stock molds

SHEET ONE HUNDRED TWENTY-NINE

Handy combination of attractive condiment sets with matching closed or open face clock cases, and large utility handles are available from stock without mold cost, provided that restrictions on supplies of raw materials, etc., have not limited current production. For manufacturers' names and addresses, write Stock Mold Dept., Modern Plastics, Chanin Bldg., New York

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1507. Large curved handle, 8 7/8 in. long, 7/8 in. wide. 2 No. 10—32 tap brass inserts 6 1/2 in. apart. Colors: black, white and gray

1508–10. Curved condiment set with matching clock case. Salt and pepper shakers 3 in. long, 1 11/16 in. wide, 3 5/8 in. high, with chrome lettering. Case, 5 3/4 in. long, 2 3/16 in. wide, 3 5/8 in. high; clock face opening, 3 3/8 in. wide, 2 11/16 in. high. Colors: black and white

1511. Ribbed pull handle, 5 1/2 in. long, 1 in. wide. 3 ribs. Drilled and tapped 5 in. apart for No. 8—32 screw. Colors: black, ivory and blue

1512. Curved handle, 5 1/2 in. long, 1 in. wide, 2 No. 10—32 tap brass inserts 3 1/2 in. apart. Colors: black, white and gray

1513. Corrugated pull handle, 5 1/2 in. long, 1 in. wide. Drilled and tapped 5 in. apart for No. 8—32 screw Colors: black, ivory and blue

1514–16. Condiment set with oblong shakers and matching clock case. Salt and pepper shakers 1 5/8 in. long, 3 in. wide, 3 5/8 in. high, with chrome lettering. Matching case same as 1509 but with closed face. Colors: black and white

SPI Pacific Coast conference

MORE than 300 persons attended the first western conference of the Society of the Plastics Industry, Inc., held at the Ambassador Hotel in Los Angeles on February 23, 1943.

Under the chairmanship of James D. McDonald, McDonald Mfg. Co., the meeting was opened with a message of welcome from the Hon. Fletcher Bowron, Mayor of Los Angeles. Mayor Bowron told the audience that he felt the meeting to be a significant one of a great and expanding industry. Emphasizing the comparative youth of the plastics industry, he said that, like all things connected with youth, there was in it an intense and driving energy which he was quite sure would carry it forward to even greater accomplishments than ever before.


JAMES D. McDONALD

Tracing the part which the plastics industry has played in war production, William T. Cruse, executive vice-president of SPI, told the conference that no section of the country has made greater progress than the Pacific Coast in the utilization of plastics for war.

"The plastics industry on the Pacific Coast has forged ahead in the war program. In the Pacific Northwest, plywood bonded with plastics has been used in many essential ways. Where previously plywood had been manufactured with vegetable and animal adhesives, their applications were restricted by the limitations of these types of adhesives. With the adoption of synthetic organic adhesives such as phenolic and urea resins or varnishes, the horizon of possible war applications for plywood was vastly expanded. These adhesives provided the weather and moisture resistance stability which permitted their use in many different places.

Mr. Cruse then took up the activities of the SPI in the war program. He outlined the function of its five principal operating technical committees and gave a specific explanation of how they have been of assistance to the armed services in the solution of technical problems.


WILLIAM T. CRUSE

W. C. Goggin, Dow Chemical Co., gave a talk on saran, illustrated with slides depicting various technical data connected with handling the material. The speaker warned that in handling saran molders must work diligently and with care to have the finished product turn out properly. However, he mentioned that when proper precautions were taken the quality of the finished piece justified such care.

Mr. Goggin went on to say that saran is a thermoplastic material of crystalline nature which is characterized by great chemical resistance and toughness at room temperature. He revealed that, although it can be copolymerized with a great variety of other materials, this has been done only experimentally and but few of these copolymers are commercially available as yet. Due to the crystalline nature of the material, the speaker said, the melting point of saran is relatively sharp. To the molder this means that in handling saran temperatures must be very carefully controlled, otherwise proper flow conditions will not be obtained, Mr. Goggin emphasized. In closing, Mr. Goggin said that saran showed great resistance chemically and high resistance to physical fatigue and had great potentialities both for injection molding and extrusion.

A comprehensive summary of the supply and use status of the important types of plastic materials was delivered to the conference by Frank H. Carman, Chief of the Plastics and Synthetic Rubber Section of the Chemicals Division, WPB. Mr. Carman said that probably no aspect of the wartime plastics program has been more widely publicized and less understood than the substitution and replacement of metals and other critical materials with plastics.

Mr. Carman revealed that there are certain expansion programs being made in the chemical industry which are of interest to the plastics industry. Some of those falling in this category, he said, are new plants or expansions for: phenol, paraphenyl phenol, tar acid refineries, and phenolic resins; acrylic resins and cast methyl methacrylate sheet capacity; polymers and copolymers of vinyl acetate and vinyl chloride; acrylonitrile and styrene, ethyl cellulose and melamine, and alcohol, acetone, tricresyl phosphate and esters. In addition, there are a number of plants for secret materials, and fabricating capacity for plastics manufacture is being expanded.


FRANK H. CARMAN

The Chief of the Plastics Section then discussed the supply situation in each of the major plastics raw materials groups. He revealed that phenolic resin will continue to be in restricted supply over the next several months to the extent that even direct military uses of lesser importance may not be taken care of.

"As already emphasized, the supplies of tar acid for resin and molding powder manufacture will continue to be tight over the next several months," Mr. Carman said. "There is an especially critical shortage in the case of certain cresols required for direct war use in resins and in other chemical products. All manufacturers and users of these materials are urged to substitute the more available tar acids for cresols. If large scale substitutions are not effected in the immediate future, it is possible that many direct war applications will not be supplied in the required amounts." Mr. Carman revealed that the producers of urea molding material are now operating at about capacity with a backlog of orders ranging from 4 to 6 weeks.

In melamine, current demand has exceeded availability, but the speaker expressed the opinion that by certain conversions of existing plants it might be possible to increase melamine production capacity by as much as 300 percent during 1943. Mr. Carman stated that the supply situation in methyl methacrylate cast sheet and molding powder is the most critical situation with which the Plastics Section of WPB has to contend. Even with a vast expansion of capacity, he revealed that the amount of cast sheet still falls short of meeting aircraft requirements. For this reason he recommended that every conversion step possible be taken.

The allocation of vinyl resins in February was 94 percent for military usage, Mr. Carman said. He expressed the thought that there would probably be sufficient quantities of all the important vinyl polymers to take care of the established military uses, and that unless unforeseen delays are encountered there will be an increased capacity for the production of polyvinyl chloride amounting to about 60 percent which should become effective in the third quarter of this year.

The supply of saran or vinylidene chloride so far has been ample to take care of all war uses now established. However, Mr. Carman said that any one of a number of recently develope duses, military or non-military, are capable of requiring the entire available tonnage. In the cellulose plastics, Mr. Carman revealed that ethyl cellulose is extremely critical and cellulose nitrate is also under full allocation through General Preference Order M-196. The other cellulose plastics are limited to some extent due to lack of plasticizers. As far as plastic processing machinery is concerned, Mr. Carman said that the recent amendment to Order L-159 has placed certain types of plastic machinery, new or used, under full allocation by the WPB.

"It is expected that certain rubber processing equipment which can be used in processing plastics will also be placed under this order. I wish to make it clear that the War Production Board has no intention of preventing anyone from obtaining new equipment for molding or processing plastics, when such equipment is necessary for the war effort and alternate facilities are not available. But it

should certainly be no news to the industry that there are still a large number of machines operating on civilian products only part time, or in some cases actually idle. Because of other requirements for machine tool facilities and because of the critical metals and electrical components which go into new plastics machinery, we cannot justify the continued manufacture of such equipment except on grounds of clearly established war necessity. I regret to state that there has been a reluctance on the part of many processors to give up civilian business. So long as any sizable proportion of the molding and extrusion equipment of the industry is still engaged in non-war production, we are prepared to take whatever steps are necessary to prevent an undue expansion of processing machinery and facilities to the disadvantage of other more important work. If the industry itself does not get together to see that all available facilities are put to use before requesting new machinery and equipment, then the War Production Board will have little choice but to accomplish the same results by mandatory action which may include the requisitioning of machinery."

W. C. GOGGIN

Summing up, Mr. Carman asked the industry to help the Plastics Section of WPB by making every effort to use the least critical material when designing a plastic product and not to substitute plastics for metal just for the sake of saving a critical material. "It should be remembered," he concluded, "that the ability of our industry to produce plastics materials as compared to capacity of metal industry is in the approximate ratio of pounds to tons."

James L. Rodgers, Jr., president of Plaskon Co., Inc., talked on the development of melamine-formaldehyde resins in combination with certain fillers. Mr. Rodgers said that these new resins combined the most desirable properties of the familiar urea and phenolic molding compounds to a degree which was not possible before their introduction. As an example of what he meant by this, Mr. Rodgers said that the melamine compounds combine the unlimited color possibilities and fast molding cycles of the ureas with a chemical resistance comparable to that of the phenolics. The outstanding resistance of ureas to oils and solvents is combined with the superior water resistance of the phenolics; and for uses in electrical equipment, mineral-filled melamine compounds combine the unusual arc resistance of ureas with the heat resistance and desirable dielectric properties of the phenolics, according to the speaker.

Going back to the beginning of the material and its development, Mr. Rodgers explained that melamine contains only carbon, nitrogen and hydrogen in the same proportion in which they would occur if one molecule of water could be removed from a molecule of urea. He then described the molecular structure of melamine and said that it was quite similar to that of phenol.

"The first melamine molding compounds developed and the most commonly known are those containing alpha-cellulose pulp as a filler. These compounds are almost identical with ureas in appearance and molding properties. The molded material, however, has considerable more chemical resistance than the ureas and is definitely harder and more heat resistant.

The heat resistance of the melamine resin is also an important property, Mr. Rodgers said, because it allows the maximum permissible molding temperature to exceed that of ureas by 20° or 30°, with a corresponding decrease in cure time. He warned, however, that since objects molded from melamine compound are considerably harder than those from urea compounds, especially when being removed hot from the mold, precautions must be taken that molds have little, if any, undercuts in order to prevent the sticking of the piece in the mold.

Rag filled melamine compounds have recently been developed which have a very high impact resistance and flexural strength, in addition to the arc resistance and the general inertness of other melamine resins. These compounds are especially suitable for tableware and certain specialized electrical applications, the speaker revealed.

Mr. Rodgers recommended pre-heating at *all* times, but said that it was especially desirable for thoroughly cured parts which have less water absorption and superior electrical properties.

At the luncheon session of the meeting held in the Fiesta room of the Ambassador, E. F. Lougee, chairman of the Advisory Board of the Plastics Industries Technical Institute, presided. Dr. Gordon M. Kline, Chief of the Plastics Section, National Bureau of Standards, technical editor of MODERN PLASTICS, the principal speaker, discussed plastics in war. After telling of the roles which plastics have played in the matériel of war, Dr. Kline told of the work done by various plastic testing laboratories.

JAMES L. RODGERS, JR.

"Less romantic," Dr. Kline said, "but no less necessary, the military services have plastics laboratories which today are examining an amazing array of plastics items to determine which ones can stand the test of unfailing performance under fire. One of these laboratories is the Organic Plastics Section of the National Bureau of Standards. During the past year, this plastics laboratory tested items of equipment for practically every branch of the Army and Navy. Specifications were prepared for those plastic products which successfully met the requirements and they have become standard stores in the armed forces. . . In addition to these testing jobs, many research investigations were conducted by the National Bureau of Standards plastics laboratory to develop improved materials for specific needs of the Army and Navy.

"When the supply of methyl methacrylate plastics became critical because of the rapidly expanding aircraft program, a light stabilized cellulose acetate plastic was developed at the Bureau to provide a transparent material with satisfactory weathering resistance to be used on aircraft. This plastic is now in commercial production and has eased the supply situation in transparent plastics. Another urgent problem presented itself when our airplanes began to concentrate in tropical climates. The combination of intense ultraviolet light and high moisture content in the air caused a rapid deterioration of the plastic coating on airplane fabric. This problem was solved by the Bureau by the development of an airplane dope based on cellulose acetate butyrate plastic. This new dope not only weathers better than the old one, but it also overcomes the fire hazard which existed when cellulose nitrate was used as the base of the dope."

GORDON M. KLINE

Dr. Kline then discussed the problem of preparing specifications and said that it had been an important part of the work of the Organic Plastics Section of the Bureau. In this work, he revealed, the Bureau has cooperated with the Federal Specifications Executive Committee, the American Society for Testing Materials, the Society of the Plastics Industry and the Society of Automotive Engineers.

The British use of plastics in military applications was dealt with briefly by Dr. Kline, although he said that for obvious reasons details of those applications could not be revealed today. However, he emphasized that in Britain plastics "are in the thick of it" on land and sea and in the air.

In the afternoon session, over which Mr. Lougee presided, Lieut. Daniel M. Magee, Plastics Advisor, Army Air Forces—Matériel Command, Western Procurement District, showed a number of the outstanding plastics applications for aircraft. Numbered among these were the transparent cockpit enclosures, various laminates, control wheels and similar items.

A comprehensive summary of methyl methacrylate sheet material developments for the aircraft industry was given to the conference by Dr. J. W. Shackleton of E. I. du Pont de Nemours & Co., Inc. Dr. Shackleton outlined the early use of cellulose nitrate and acetate for windshields and then described the development of methyl methacrylate sheeting for transparent parts on aircraft.

"There has been some criticism of the abrasion resistance of

methacrylate cast sheeting. Other transparent materials have been developed," Dr. Schackleton said, "which claim superiority over the methacrylates in this respect. Our research department has discovered numerous hard, transparent resins with surface hardness many times that of the methacrylates themselves, but it is our belief that the problem resolves itself into increasing the surface hardness without sacrificing other valuable properties. We are giving the problem every consideration, but still believe that methyl methacrylate embodies an optimum choice of properties for airplane enclosure material. There is no 'universal plastic,' to use a time-worn phrase, so it is well to consider all properties together."

E. F. LOUGEE

"One of the points of concern in early applications of methacrylate to aircraft," the speaker said, turning to another subject, "was a suitable method of mounting panels or curved sections on the plane. After many hit-or-miss devices were tried, adequate methods were worked out and, if recommendations are followed in design, a minimum of breakage can be expected. These recommendations are, in essence, avoiding of stress concentrations, channel mounting instead of mounting with bolts and rivets, and proper cushioning between plastic and metal retaining parts."

In closing his address, Dr. Schackleton said that his company was continuing its research, and improved methods for laminating this plastic and for forming it have been developed. Also, new methods of attachment have been worked out and pressure deflection and shooting tests are in progress.

The future of plastics in the postwar world as a result of wartime developments was the subject of a speech by John Delmonte, technical director of the Plastics Industries Technical Institute. After sketching briefly some of the major developments in plastics, Mr. Delmonte took up the angle of how to achieve greater use of them in the future by encouraging engineers and technicians responsible for material developments to reason along the following lines: "Here is a part required for a certain assembly. It can be manufactured out of metals, out of plastics, or out of a combination of both. I will design it from the materials which will give it functional perfection at the lowest cost."

Mr. Delmonte then went into the combination of plastics with other materials. He stated that such combinations are growing rapidly and discussed particularly the use of plastics in conjunction with textiles, woods, inorganic materials, metals and liquids. In the field of metals and plastics combinations, Mr. Delmonte strongly urged plastics molders to familiarize themselves with powder metallurgy, "for therein is an industry in which they can make outstanding contributions."

In the field of liquids, the speaker cited the recent activity in resin-ion exchangers as particularly worthy of note and said it promised important things in the development of water and liquid purifiers.

In postwar machine and product design, Mr. Delmonte predicted a continuation of the trend toward the use of more plastics for both decorative and functional uses. The use of plastics as building materials will also take a sharp upswing, Mr. Delmonte forecast.

Dr. Irving Muskat, Marco Chemical Co., discussed the recent developments of what he termed "the low pressure resins." Dr. Muskat said that although his talk was titled "The New Allyl Alcohol Type Resins," he was not going to discuss them to any great extent, because, he stated, low pressure resins of the polymerizable type can be produced without the use of allyl alcohol.

The speaker emphasized the advantages of these new type resins and stressed particularly the laminating possibilities which they have. According to Dr. Muskat, the primary difficulty in the use of synthetic resin bonding agents of the condensation type in laminates can be narrowed down to one point: the difficulty of fabrication. They require complicated handling techniques, large pieces of equipment and the exertion of high pressures.

All of this, he went on to say, is done away with by the use of the low pressure resins of the polymerizable type which are handled with less than 15 p.s.i. pressure. Through their use, laminations can be made which have extremely good chemical and physical properties and excellent strength characteristics. As a matter of fact, Dr. Muskat said, low pressure resin laminates compare quite favorably in every respect with those requiring higher pressures. Principal difference is that high pressure laminates can naturally have more layers and therefore a greater density. But generally speaking, Dr. Muskat claimed, this will not give substantially better performance characteristics.

With the use of low pressure resins, laminating can be done with pressures ranging from zero p.s.i. to 15 p.s.i. He showed one dome-shaped canvas laminate fabricated from MRIA resin which had been made with no external pressure and said that it had proved satisfactory from all performance standards.

In closing, Dr. Muskat predicted an ever-increasing use of these low pressure resins in the field of laminating for structural purposes and said that their properties lent them to easier and simpler usage which would in turn mean wider usage.

IRVING MUSKAT

Activities of the Plastic Molders Committee were detailed to the conferees by Allan W. Fritzsche, General Industries Co., chairman of the Committee. Mr. Fritzsche pointed out that the Molders Committee was formed in October of 1941 when the molders of the country were experiencing great difficulty in securing molding materials, especially in the thermoplastic group. Accordingly, a committee was formed to develop a program for assembling, collecting and, in turn, presenting facts to the appropriate U. S. Government Departments concerning the plastics industry. He made it clear that the Molders Committee is not associated with SPI in any way, and also that the funds necessary for the financing of the committee's activities have been contributed on a voluntary basis by the molders.

The chairman of the Molders Committee then told of the types and kinds of questionnaires which the committee sent to all plastics molders to get statistical ammunition to prove its case with the Government. All of this was before Pearl Harbor. After that date the problems were multiplied a hundredfold, Mr. Fritzsche told the audience, and many concerns would have been wiped out of business entirely if they hadn't been able to switch over from thermosetting to thermoplastics after the issuance of the M-25 order.

At about this time, labor organizations in the industry found that material shortages meant loss of members due to the subsequent cancellation of civilian business, so they went to Washington and asked for relief on the materials situation. This, Mr. Fritzsche said, was one of the first instances of labor and management groups working together on a problem of this type.

Mr. Fritzsche urged a thorough study of the various price regulating orders and said that he did not think they were generally understood, but that they have teeth in them and should be thoroughly studied by all in the industry. Mr. Fritzsche made it quite clear that the Molders Committee disagreed with the Army about the injection molding machine shortage and that the committee felt there is a definite shortage of thermoplastic injection war *business* but not of *machines*.

ALLAN W. FRITZSCHE

High impact molding materials were reported on by C. H. Whitlock, Monsanto Chemical Co. Mr. Whitlock said that in the past year molding materials have been formulated with impact strengths two or three times the strength of macerated canvas filled materials, but due to their fairly recent development they are not generally known. The war, Mr. Whitlock added, has given a tremendous impetus to development work on high impact materials and a wide range of fillers have been investigated and their effect on physical and mechanical properties and molding characteristics has been evaluated.*

*See MODERN PLASTICS *19*, 70 (June 1942).

A series of slides was then shown by Mr. Whitlock which illustrated the effect of varying temperature conditions on the properties of various types of molding compounds.

"In the past the molder has been more or less reluctant to handle high impact molding compounds," Mr. Whitlock continued, "but today he is confronted with the fact that high impact materials must be used. The high bulk factor common with high impact materials is responsible for most of the difficulties encountered. Fabric filled materials have a bulk factor of approximately 10 to 1.

"Excessive gassing of high impact materials is also usually encountered during the molding operation. We attribute a great deal of this trouble to the inability of the gas to escape because of the deep loading well above the cavity. In reality there is no more reason for gas blisters in high impact materials than in woodflour, general purpose material. The breathing of a conventional mold designed for high impact materials does not seem to correct the blistering problem in all cases. This can be attributed to the fact that even though the seal between the long force and the side wall of the cavity is partially broken the same benefits cannot be realized as when breathing a flash type mold."

Other mechanical problems were taken up by the speaker, who gave various methods of solving them successfully. At the conclusion of his talk, Mr. Whitlock showed a piston reamer which consisted of only 8 percent steel and 92 percent plastics.

"Since the development of this reamer," he concluded, "other types of end mills and milling cutters have been experimented with and it appears that these machine tools are entirely satisfactory."

The afternoon session of the conference was closed by the first western showing of MODERN PLASTICS magazine's new sound and color motion picture, "This Plastic Age." The film was introduced by Raymond R. Dickey, editor of the magazine, who explained the reasons for making such an educational picture.

At the banquet which closed the session, Ronald Kinnear, president of the Society of the Plastics Industry, said that the issue of the war is the only issue by which mankind has ever been preserved and can hope to preserve its freedom, dignity and self respect.

"We have the biggest task before us that has ever confronted the world or the nation. It cannot be done alone," he said, "but only by pulling together. Everything of national effort in cooperation, everything of individual contribution, must be given to succeed in every line, and every clime, to pay the debt we owe for what we have, and for what we hope to enjoy in a future world of peace."

Mr. Kinnear, before closing his speech, presented to W. T. Cruse what he termed an "Oscar," a hand-worked caricature of Mr. Cruse, for outstanding performance in the plastics industry during 1942.

John K. Northrop, president of Northrop Aircraft, Inc., warned the plastics industry against too much enthusiasm and said that he was afraid the enforced swing to plastics materials was, in many cases, regarded by the aircraft designer as just another headache. However, he said that others feel plastics may well be the answer—even for structural materials—and that these designers look confidently to the research laboratories to cure the ills which have discouraged so many, and stopped entirely some ambitious attempts to substitute plastics for metals. However, Mr. Northrop said that excluding resin-bonded plywood, he did not feel that plastics as structural members of an aircraft would make any particular headway until after the war was over.

"New materials are penalized with a high factor of safety until we know for certain that they will do the job under the worst possible conditions and over a considerable period of time. In addition to this, it must be remembered that until recently there have been other disadvantages associated with extensive use of plastics for major structural parts. The problem of applying the high temperatures and pressures ordinarily required to large and complicated members has been nearly insurmountable. Only recently have developments uncovered a group of plastics combining interesting physical properties with low pressure setting properties.

Mr. Northrop then turned to the part plastics are playing in plane accessories and predicted an even greater future along that line than is now being enjoyed by the plastics industry. In concluding his speech, Mr. Northrop said, "It is my considered opinion that a plastic having all the qualities necessary in a major structural member is just now emerging from the chemists' test tubes, *if in fact* it has not already emerged. On the other hand, a comparatively small portion of the total gross weight of an airplane is basic structure or power plant, and everything else, including the payload, can well be a plastic product."

The part which plastics play in the work of the Signal Corps was the subject of a speech delivered by Brig. General Stephen H. Sherrill, Commanding General, Western Signal Corps Training Center, Camp Kohler, Sacramento, California.

"The entire Army depends upon the Signal Corps to 'get the message through,'" General Sherrill said. "That, in a sense, is our motto—'get the message through.' The men of the Signal Corps, in turn, depend on the quality and ruggedness of their equipment. In so doing, they depend to a very great extent on plastics—the plastics developed and fabricated in the laboratories and factories which you represent.

STEPHEN H. SHERRILL

"It would be difficult for one of our soldiers at Camp Kohler to spend even a small part of a training day without coming into contact with things made out of plastics. At every stage of the way, in our work with telephone, telegraph and radio equipment, we make use of these magic materials of modern industry. It would be difficult also to imagine a message getting through from the commander of an overseas theater to his advance combat units without the help of plastics. So thoroughly are these materials in use to support, separate, inclose and insulate the components of our equipment that, if plastics were suddenly removed from our communication lines, there is hardly an electrical circuit which would not become a short circuit. Even when we send a message by carrier pigeon, the dispatch is carried on the bird's leg in a plastic capsule."

After discussing the conversion of the plastics industry to a wartime industry, General Sherrill discussed the rôle of "hidden plastics" in Signal Corps equipment. "They do not decorate the surface of our radio communication sets," he said, "but they play a tremendously important rôle in the very guts of those sets. Inconspicuous, dull in color and tone, these plastics are performing an indispensable function in all military communications equipment.

"The use of plastics for insulation has been an outstanding feature of the simultaneous development of the plastics industry and the electrical industry during the present century. We find phenolics used as insulators throughout our radio sets and power units. We find laminated plastics punched into washers and disks for the separation and insulation of electrical elements. These materials answer our requirements for electrical resistance, dielectric strength, lightness, ruggedness and resistance to moisture and corrosion under the severe conditions to which all Signal Corps equipment is subjected.

General Sherrill said that he knew it was no easy job to provide new materials to order, but just for the sake of furnishing a goal to shoot at, he passed along a hope that had been expressed to him from the engineers in the Signal Supply Services of the War Department. "They would like it very much if you gentlemen of the plastics industry would invent more thermoplastics which will keep their characteristics at higher temperatures. They would particularly like to have materials, in addition to nylon, which can be injection molded and still be able to stand boiling temperatures. They would also like to have these materials capable of retaining their toughness at temperatures of 50° or more below zero.

"Perhaps we are inclined occasionally," General Sherrill said in conclusion, "to ask you to do the impossible. I am told that, up to date, the plastics industry has done just about everything that is possible and some things that a few years ago seemed impossible in the way of supplying materials in the quantity and the quality that is called for by this emergency. During 1942, the Signal Corps set itself a goal which called for multiplying its rate of procurement more than 1300 percent. That goal was fully achieved. It could not have been achieved without the complete cooperation of the plastics industry, of which the Signal Corps is now directly or indirectly one of the foremost customers."

Mechanical tests of cellulose acetate[1]

by WILLIAM N. FINDLEY[2]

THIS paper reports additional tests of a cellulose acetate plastic for which tests have been reported in two previous papers. The first paper[3] reported static tension tests at a wide range of speeds of testing. It was shown that increasing the speed of testing increased the static strength of the acetate up to a certain point. Data showing the effect of stress on the time for fracture under a constant tension load were given and fatigue tests with a repeated bending type fatigue machine showed the effect of notches on the endurance limit, and also the effect of shape of specimen on the endurance limit. The effect of stress on the temperature developed in the fatigue specimens was also shown. The second paper[4] reported creep tests at constant temperature for several different stresses and showed the relationship between stress and rate of creep.

The present paper presents additional tests on the same sheet of cellulose acetate plastic. Static tests are presented to show the effect of initial moisture content on results of compression tests at various periods of time. Tension, compression and torsion static tests at three different rates of strain provide data on the effect of rate of strain, and on the comparative properties of the material under these three loading conditions. The effect of a transverse hole on the results of the static tension test is also shown. Additional data are presented to show the effect of shape of specimen (circular, square and rectangular in cross section) on the endurance limit, and the effect of the temperature of the specimen on the endurance limit. In addition, the effect of speed of testing on the endurance limit is shown for a range of speeds from 42 to 2900 r.p.m.; and the effect of range of stress on the endurance limit is also shown. The last two variables mentioned are of particular importance, because material may be subjected to vibration at both very low and very high frequencies, so that a knowledge of the ability of the material to resist vibration at these frequencies is important. Also the range of stress is frequently not a complete reversal during the vibration of a member, and in order to avoid failure one should know whether the endurance limit for ranges of stress, other than complete reversal, is the same as for completely reversed cycles of stress.

The purpose of this investigation was twofold. First to obtain as complete information as possible on the mechanical properties of cellulose acetate plastic, and second to evaluate the effect of certain variables such as speed of testing and others (discussed above) on the results of mechanical tests. This latter type of information is needed in order properly to take account of such variables when setting up specifications for testing, and when designing members to resist loads under different conditions of speed, range of stress, etc.

A study of the properties of cellulose acetate plastic reported in this paper required the control during the tests of a number of variables which are unimportant in the testing of metals under similar conditions. Among these were small changes in temperature and relative humidity, so that a special laboratory maintained at constant temperature, 77° F., and constant relative humidity, 50 percent, was required for the tests. Many of these tests also required the development of special machines and instruments since available equipment was unsuited to tests of this material.

Materials and specimens

The cellulose acetate plastic for these tests was supplied by the Plastics Division of the Monsanto Chemical Co. The material was a clear, transparent thermoplastic composed of medium viscosity cellulose acetate of the acetone soluble type, plasticized with about 26 percent of phthalate and aromatic phosphate ester plasticizers. The Monsanto formulation number was 2050 TV.

All specimens used in these tests were cut from the same sheet of cellulose acetate plastic as that used for the tests reported in the two previous papers. The sheet was 0.3 in. thick and was made by the sheeter process, at a molding temperature between 200° and 250° F. The finished sheet contained less than one percent of residual solvent and water, and had a Rockwell hardness of about L40 at 77° F., 50 percent relative humidity.

A drawing of the specimens used is shown in Fig. 1. All specimens were machined with the longitudinal axis parallel to the short side of the original sheet. The specimens were cut from the sheet on a jig saw and then milled or turned to the shape shown in Fig. 1. The machined edges were then smoothed by hand with No. 00 emery paper so as to remove all burrs and scratches, leaving the final polishing marks parallel to the axis of the specimen. The compression specimens were not smoothed after machining, because of the fact that slight surface scratches would not affect the results inasmuch as the material did not fracture under a compressive load. All specimens were conditioned by allowing them to remain in the atmosphere of the testing laboratory for a period of at least two weeks prior to the start of the tests, and remained in the laboratory continuously thereafter. The laboratory was maintained at a constant temperature of 77° ± 1° F., and 50 ± 2 percent relative humidity continuously throughout the duration of the tests.

Static tests

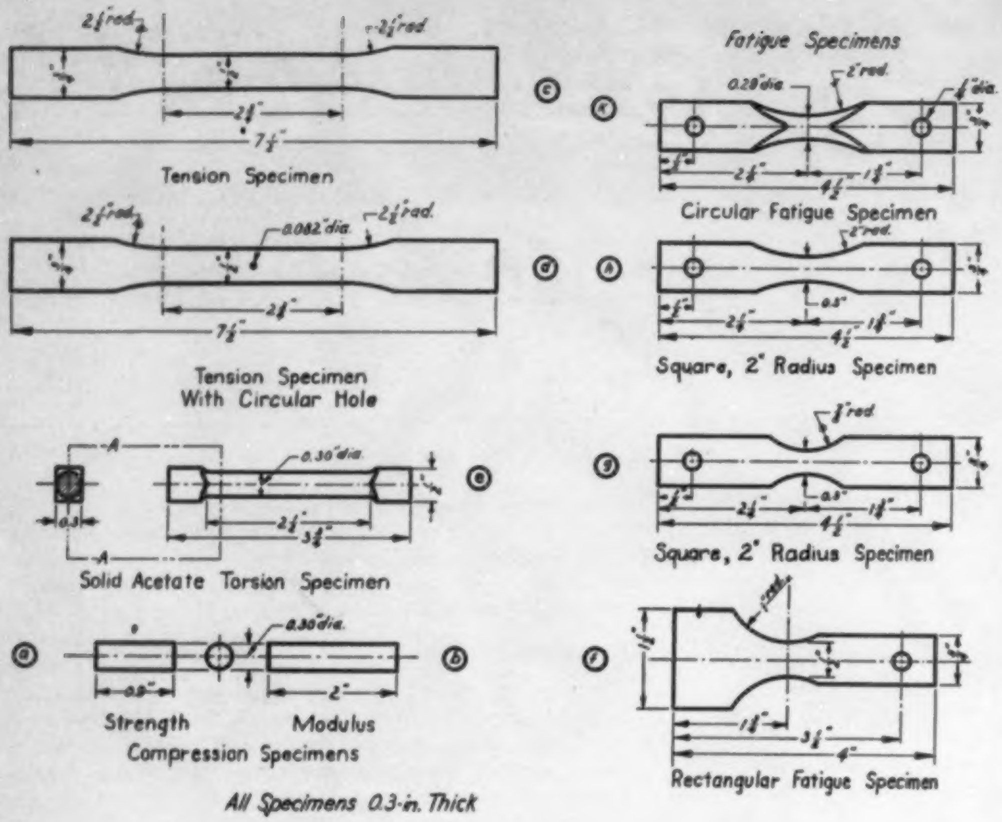
The effect of initial moisture content. Fifty specimens were machined as shown in Fig. 1a from the ends of specimens used previously for fatigue tests. This portion of the fatigue specimen had not been damaged in any way by the fatigue tests. These specimens were given the following treatment. Twenty-five of them were immersed in water for a period of 48 hr., and then removed to a rack where they remained until tested. The other 25 were placed in a desiccator over anhydrous calcium chloride for a period of 48 hr. and then removed and placed on a rack. Both groups of specimens were then stored at constant temperature and relative humidity in the testing room for the duration of the tests. Two specimens from each group were set aside as control specimens, and the weight and length recorded both before conditioning and at intervals of time after the above treatment. The remainder of the specimens were tested in compression at intervals of time for over one year. One specimen was tested immediately after removal from the water bath and another

[1] This paper was presented before the Rubber and Plastics Group of the American Society of Mechanical Engineers in New York on December 3, 1942, and is published here through the courtesy of that Society.

[2] Associate in Theoretical and Applied Mechanics, College of Engineering, University of Illinois.

[3] William N. Findley, "Mechanical Tests of Cellulose Acetate," *Proceedings*, American Society for Testing Materials *41*, 1231 (1941); MODERN PLASTICS *19*, 57 (Sept. 1941).

[4] William N. Findley, "Mechanical Tests of Cellulose Acetate: Part II on Creep," *Proceedings*, American Society for Testing Materials *42*, (1942); MODERN PLASTICS *19*, 71 (Aug. 1942).



1—*Specimens in shapes attained following forming from sheet*

immediately after removal from the desiccator. The other specimens were tested at intervals of time so as to give a uniform distribution of data when the test results were plotted against the logarithm of the time elapsed from the time of removal from the conditioning medium. All tests were run at a no-load head speed of 0.06 in. per minute. This resulted in a rate of strain of about 0.002 per minute.

It was observed that a definite yield point in compression exists for cellulose acetate plastic. This was determined by the fact that the load remained constant for a period of time during the test. Since fracture did not occur during the compression test, the yield point was used to measure the effect of moisture on the strength of the material. In Fig. 2, the compressive yield point for these tests is plotted against the elapsed time. It was observed that a time of about 1 1/3 months (1000 hr.) was required for the compressive yield point to approach a stable value, and it is significant that the end point for both the moistened specimens and the dried specimens was nearly the same. Some scatter in these data was observed, due in part to the fact that the air conditioning of the laboratory was interrupted for 4 or 5 hr. on two or three occasions.

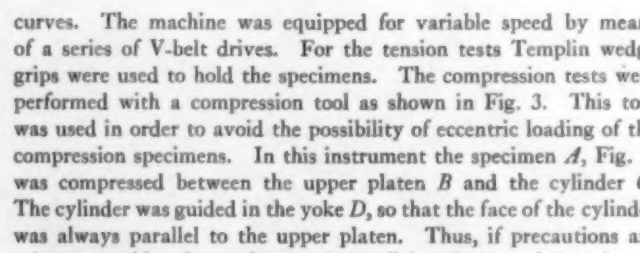
In the lower part of Fig. 2 is shown the average specific weight of the two control specimens, plotted against the lapse of time. These control specimens were weighed and measured at the same time that tests of the other specimens were made. The data shown in Fig. 2 indicate that a time of about one month was required for the specific weight to return to the value which was obtained before the conditioning was started. No explanation is offered for the fact that the specific weight of the initially dry specimens decreased after 7000 hr. unless perhaps the specimen was losing plasticizer.

No appreciable change in length of the specimens was observed as a result of the above treatment. The wet specimens decreased about 0.4 percent in length during the testing period while no measurable change in length of the dried specimens was observed.

The effect of rate of strain on tension, compression and torsion tests. Static tension, compression and torsion tests were performed at about the same time on specimens of the shape shown in Figs. 1c, 1b and 1e, respectively. These tests were performed in a universal testing machine shown in Figs. 3 and 4. It was a single-screw machine of 1500-lb. capacity arranged with pendulum weighing, and equipped with a device for semi-autographic recording of load-deformation curves. The machine was equipped for variable speed by means of a series of V-belt drives. For the tension tests Templin wedge grips were used to hold the specimens. The compression tests were performed with a compression tool as shown in Fig. 3. This tool was used in order to avoid the possibility of eccentric loading of the compression specimens. In this instrument the specimen *A*, Fig. 3, was compressed between the upper platen *B* and the cylinder *C*. The cylinder was guided in the yoke *D*, so that the face of the cylinder was always parallel to the upper platen. Thus, if precautions are taken to machine the specimen ends parallel, and center the specimens on the cylinder, the amount of eccentric loading should be negligible. These compression tests were made on specimens 2 in. long and about 3/10 in. in diameter, so the l/r ratio[5] was about 27. This length of specimen was necessary in order to accommodate the compressometer. The compressometer had a gage length of 1 in. and consisted of a one-to-one lever to which was attached a one-thousandth dial. The instrument was attached to the specimen by means of pointed screws on opposite sides of the specimens, so that the strain measured was the average strain in the specimen.

[5] l/r refers to the ratio of the length of the specimen to the radius of gyration of the cross section of the specimen.

2—*Effect of time and conditioning on yield point in compression and specific weight plotted against time lapse*



Compression tests performed on the 2-in. specimen were used to determine the modulus of elasticity and shape of the stress-strain diagram in compression. A still longer specimen would be desirable to increase the accuracy of strain measurement. The effect of buckling would, however, become more serious with longer specimens. In order to obtain the values of compressive yield strength, a shorter specimen, about $^9/_{10}$ in. long, was used.

The l/r ratio for the short specimen was about 12. The yield point observed with the short specimens was 4900 p.s.i. at a rate of strain of about 0.002 per minute.

It was necessary to design and build special apparatus for torsion testing of plastics because machines of low capacity were not available. The apparatus used is shown in Fig. 4. The pendulum weighing system of the tension testing machine was used as the torque-measuring device for the torsion machine. This was accomplished by attaching to the tension machine a twisting head *A*, Fig. 4, driven by a double worm drive. A special chuck *B* was attached to the shaft of this twisting head, and another chuck *C* to the axis of the pendulum *D*. These chucks were designed to apply a torque to the specimen with little danger of bending the specimen at the same time. This was accomplished by mounting the specimen on centers and applying the torque as a couple by means of adjustable screws.

The gage used for measuring the shearing strain is shown in Fig. 5. It was designed to accommodate materials whose ultimate shearing strain was relatively small and also materials which might twist two or three revolutions in a length of 2 inches. The instrument consisted of two rings, *A*, Fig. 5, which were slipped over the specimen and fastened to it by three adjusting screws in each ring. A gage length of 2 in. was obtained by use of a removable spacer *B*. To one of the rings was fastened a circular scale *C* for measuring large angles of twist. Two 10-in. arms *D* fastened to the same ring carried scales on the end which were used in measuring small shearing strains. Adjustable pointers *E* were attached to the other ring in such a way as to indicate the readings on their respective scales. Unfortunately material available for these tests allowed machining of torsion specimens only $^3/_{10}$ in. in diameter, so that some bending of the specimen resulted from the weight of the detrusion gage. However, the effect of this bending probably did not seriously affect the results of the test.

Torsion tests differ from tension and compression tests in two important respects. They differ in respect to the state of stress developed and in respect to the stress gradient. The state of stress may be defined in terms of the ratio $\sigma_{max.}/\tau_{max.}$, i.e., the ratio of the maximum tensile stress to the maximum shearing stress at a point in the stressed member. In a tension member this ratio is 2, while in a torsion member it is 1. Thus it may be that some materials will behave much differently in the two tests. The stress gradient is a measure of the distribution of stress over the cross section of a member. It has a value of zero in a tension member, but can never be zero in a torsion member. The magnitude of the stress gradient in a torsion member depends on the stress and the size of the member. The measured strength of a material may be influenced by the stress gradient so that different results may be obtained from the tension test than from the torsion test.

Results of tension tests. The tension tests were performed at three different head speeds ranging from 0.021 to 0.32 in. per minute. During the tests, readings of load, deformation and time were taken. From these readings the values of stress and strain were computed, using the original cross-sectional area for computation of stress. Figure 6 shows the tensile stress plotted against tensile strain for these three tests. It is evident that the higher rates of strain produced higher values of stress in the region beyond the proportional

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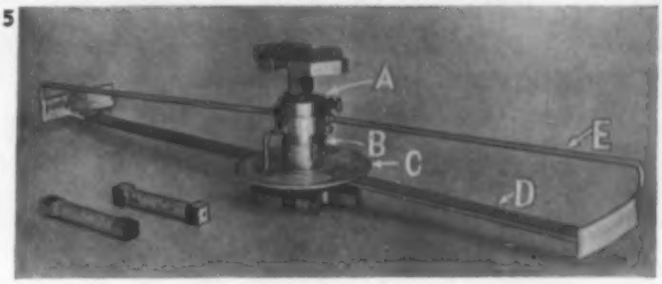
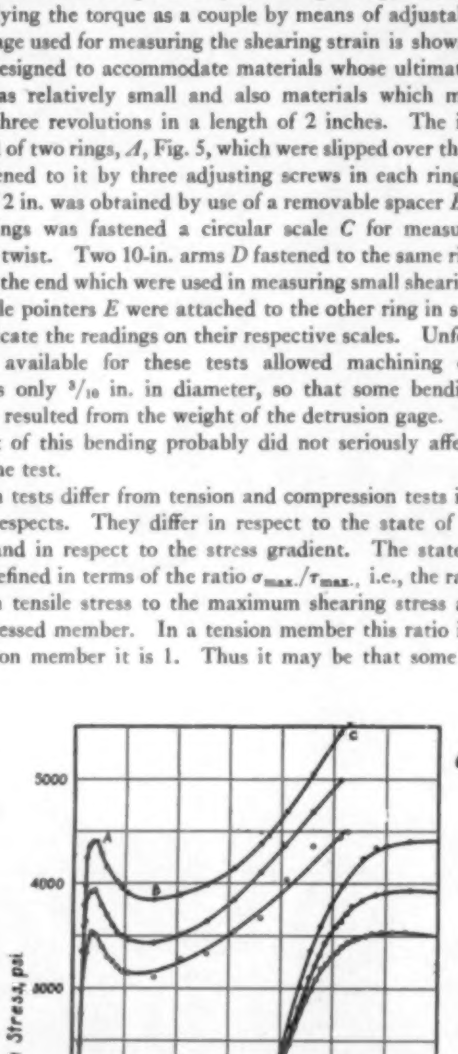


3—*Testing machine with compression tool.* 4—*Torsion testing machine.* 5—*Detrusion gage for measuring shearing strain*



6

6—*Tensile stress plotted against tensile strain.* 7—*Rate of strain computed from strain vs. time in tension*

7

limit. This was in accordance with observations previously reported.[3] It was apparent from the diagrams plotted to an enlarged strain scale that the modulus of elasticity was the same for all three rates of strain. In this paper the modulus of elasticity is designated as the ratio of stress to strain at the initial portion of the curve and is measured as the slope of the initial straight line portion of the curve. The value obtained in the tension test was

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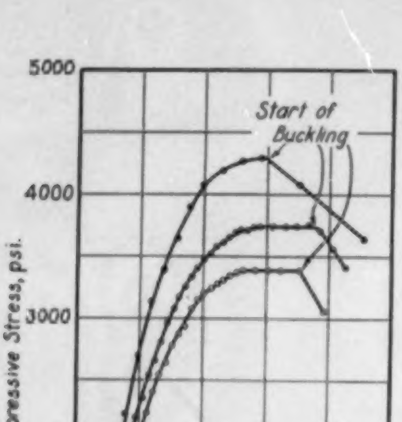

8—*Static stress vs. strain in three compression tests*

244,000 p.s.i. The upper yield point was designated as the stress corresponding to position *A*, Fig. 6. The upper yield point varied from about 3500 p.s.i. at a rate of strain of 0.0016 per min. to 4400 p.s.i. for a rate of strain of 0.04 per minute. The lower yield point *B*, Fig. 6, ranged from 3200 to 3800 p.s.i. and the fracture stress ranged from 4500 to 5500 p.s.i. for the same rates of strain given above. The rate of strain for these tests was determined from strain vs. time curves such as shown in Fig. 7, and was computed from the slope of the strain-time curve in the portion of the curve corresponding to the linear portion of the stress-strain curve. It was noticed that the rate of strain was not constant, but consisted of three fairly distinct but separate straight lines. This change in the rate of strain during a test was due in part to the elasticity of the testing machine.[3]

Results of compression tests. Compression tests were run at head speeds from 0.008 to 0.13 in. per minute. During each test readings of load, deformation and time were taken. From these data the stress and strain were computed using, as before, the original cross-sectional area in computing the stress. The stress was plotted against the strain in Fig. 8 for three compression tests at rates of strain approximately the same as those used in the tension test. It was observed in these tests that the modulus of elasticity, as defined above, was not the same for all rates of strain, but increased from 204,000 p.s.i. at the lowest rate of strain to a value of 278,000 p.s.i. at the higher rate of strain which was about ten times as fast as the first rate of strain. The yield point observed in these tests increased with the rate of strain from a value of 3400 to 4300 p.s.i. The rate of strain for the compression tests was determined from strain-time diagrams similar to that shown in Fig. 7 and the rate of strain was determined in the same way. The strain-time diagrams for compression tests were similar to those for tension, except that the test data were not obtained much beyond the yield point.

Results of torsion tests. Torsion tests were performed at three different head speeds, ranging from 0.017 to 0.33 r.p.m. During these tests simultaneous readings of torque, angle of twist and time were taken. The shearing stress at the surface of the cylindrical specimen was computed from the equation $\tau = \frac{Tc}{J}$ and the shearing strain was computed from the relationship $\gamma = \frac{c\theta}{l}$. It is recognized that the equation used for τ does not give the actual stress, except for stresses below the proportional limit. However, for comparison of the relative strength of the material under different conditions the equation is sufficiently exact. The shearing stress, as discussed above, plotted against the shearing strain is shown in Fig. 9 for three different rates of strain. The shearing modulus of elasticity was found to be the same for all three rates of strain, and had a value of 78,300 p.s.i. The values of shearing stress increased with the rate of strain, just as observed in the tension and compression tests. The upper yield point *A*, Fig. 9, increased from about 2600 to 3300 p.s.i., with increase in rate of strain; the lower yield point increased from about 2500 to 3000 p.s.i.; and the torsional modulus of rupture increased from 4300 to 4900 p.s.i. The rates of strain were determined from strain-time diagrams as shown in Fig. 10 and were computed from the slope of the curve which obtained during the linear portion of the stress-strain curve.

In order to compare values of shearing strength with values of tensile and compressive strength, equivalent rates of strain should be used for all tests. In order to accomplish this, the rate of tensile strain was kept the same for all three types of test. The maximum tensile stress occurring in a torsion member is equal to the maximum shearing stress, so that the tensile rate of strain can be computed from the shearing rate of strain by the relation $\frac{e}{t} = \frac{\gamma}{t}\frac{G}{E}$, where $\frac{e}{t}$ is the tensile rate of strain, $\frac{\gamma}{t}$ is the shearing rate of strain, and $\frac{G}{E}$ is the ratio of shearing modulus to tensile modulus. It was decided to use equal tensile rates of strain rather than equal shear rates of strain, because the material fractured along planes of maximum tensile stress under the conditions of loading studied.

Comparison of results of tension, compression and torsion tests. A comparison of the results of the three different tests shows that the upper yield points in tension and compression (long specimen) were approximately the same. However, the yield point obtained with the short compression specimen was about 40 percent higher than the upper yield point in tension. The upper yield point in

9—*Static shearing stress vs. shearing strain in torsion*

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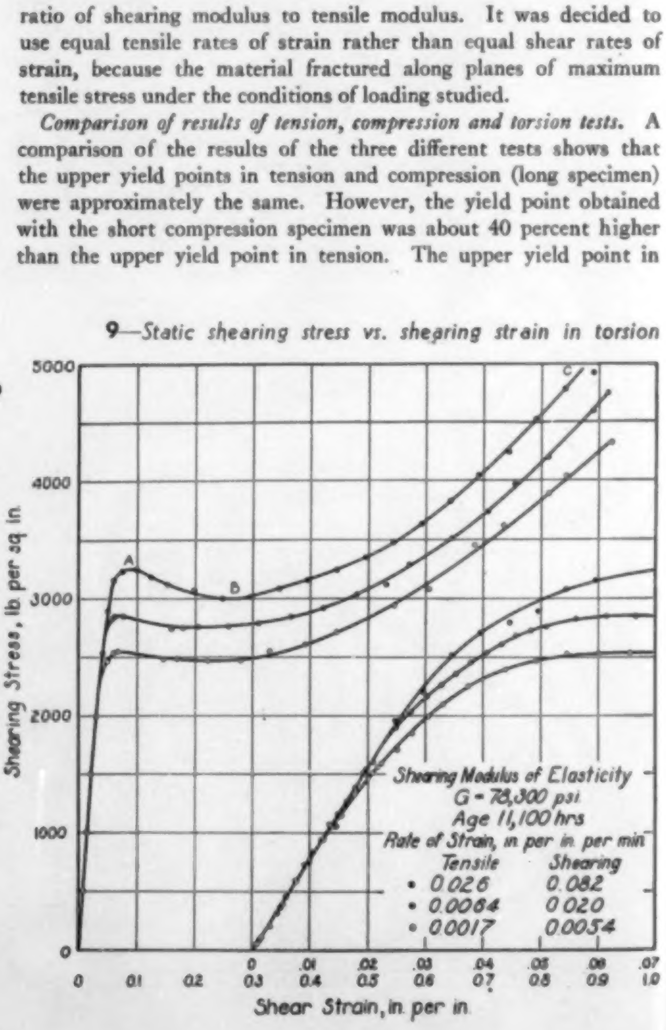

torsion was about $^3/_4$ of that for tension. In the compression test no difference was observed between upper and lower yield points. The difference between upper and lower yield points in torsion was much less than that in tension. The total strain required to rupture a specimen in torsion was 50 percent greater than that required to rupture a tensile member, whereas for compression, rupture did not occur at all for very large strains. A considerable ductility of material was shown in all tests as evidenced by maximum strains of the order of 40 to 50 percent in tension. However, the fractures were those characteristic of brittle material, as usually thought of from the standpoint of metals; that is, fracture occurred as a result of separation along the plane of maximum tensile stress, a plane perpendicular to the axis of the tensile specimen, and a 45° helix in the torsion specimen; and there was no evidence of local "necking-down" in the tensile specimen. The modulus of elasticity in tension was about equal to the average modulus of elasticity observed in the compression tests, and the modulus of elasticity in shear was about $^1/_3$ of that of the tensile modulus.

Poisson's ratio. No tests were made to determine Poisson's ratio, μ, by direct measurement and the values of modulus of elasticity in tension and in shear were not accurate enough to calculate Poisson's ratio from elastic theory with good precision. However, the following results were obtained: The elastic theory gives the relation $\mu = \left(\frac{E}{2G} - 1\right)$, where E is the modulus of elasticity in tension (or compression) and G is the modulus of elasticity in shear. The value of μ was about 0.53 to 0.56 depending on whether the modulus E was obtained from the compression or the tension test. This value is a little larger than the theoretical maximum value of $^1/_2$.

Aging. A comparison of the results of the tension tests reported above with the tests reported in the first paper[3] for the same material shows that the strength of the material has increased with age. The age of specimens at time of tests reported in the first paper was about 2000 hr. (taken from the start of the investigation) and the age at the time of the tension tests reported above was about 11,000 hr. During this time interval of 9000 hr. the upper and lower yield point increased about 4 percent at a rate of strain of 0.0016 per min. and about 8 percent at a rate of strain of 0.04 per minute. The fracture stress increased about 12 percent for both speeds, and the strain at fracture increased about 4 percent. An increase in the modulus of elasticity of about 15 percent was also observed.

The effect of a transverse hole on the tension test. Tensile specimens containing a circular transverse hole, 0.082 in. in diameter, as shown in Fig. 1d, were tested in tension to determine whether the tensile properties of the material would be affected by the stress concentration or the stress gradient resulting from the hole.

Specimens were tested at three different head speeds which resulted in rates of strain (measured over a 2-in. gage length) equal to the rates of strain used in the tension tests measured above. Readings of load, deformation and time were taken throughout the tests, and from these data the rate of strain in a 2-in. gage length and the average stress at fracture were determined. The stress-strain diagram for the specimens with the hole differed from that for the solid specimens in that no yield point was observed. The load increased gradually to a maximum value at which fracture took place. The total extension of specimens with a hole (as measured over a 2-in. gage length) was only about 8 percent of the elongation of the solid specimens. The ultimate strength was computed by dividing the maximum load by the net cross-sectional area at the hole. At a rate of strain of 0.04 per min. the ultimate strength was 5090 p.s.i. At a rate of strain of 0.0077 per min. the ultimate strength was 4350 p.s.i. At a rate of strain of 0.0016 per min. the ultimate strength was 3920 p.s.i. As in the case of tests reported in the previous article, the effect of increasing the rate of strain was to increase the ultimate strength. The corresponding values of ultimate strength for unnotched specimens were 5520 p.s.i., 5000 p.s.i. and 4490 p.s.i. Comparing these values with the values for the specimens containing holes, it is evident that the hole resulted in a decrease in ultimate strength of 8 to 13 percent.

The cause of this decrease may possibly be explained as follows: It was shown in a previous paper[3] that the fracture in a tension test occurred on a plane at right angles to the axis of the specimen. Thus failure resulted from separation of the material under a tensile stress, starting usually by a small fissure at the surface of the material. In tests of the specimen with the transverse hole, it was observed that all of the plastic deformation occurred in two wedge-shaped areas starting at the hole and spreading fan-like to the sides of the specimen. Under this condition the deformation was approximately uniformly distributed over the cross section of the solid portion of the specimen so that the total axial strain adjacent to the hole was much greater than that at the sides of the specimen where the amount of plastically deformed material was the greatest. Thus the stress distribution was not uniform during plastic extension at the cross section containing the hole—that is, the stress gradient was not zero. Stresses were much higher near the hole than at the sides. Since failure occurred by a crack starting at the hole and spreading rapidly when once formed, one might conclude that the average stress at the time that a crack started in the specimen with the hole was less than the average stress which caused a crack to start in the unnotched specimen. Thus the ultimate strength of the notched specimen would be smaller than the ultimate strength of an unnotched specimen.

10—*Shearing strain plotted against time in torsion*

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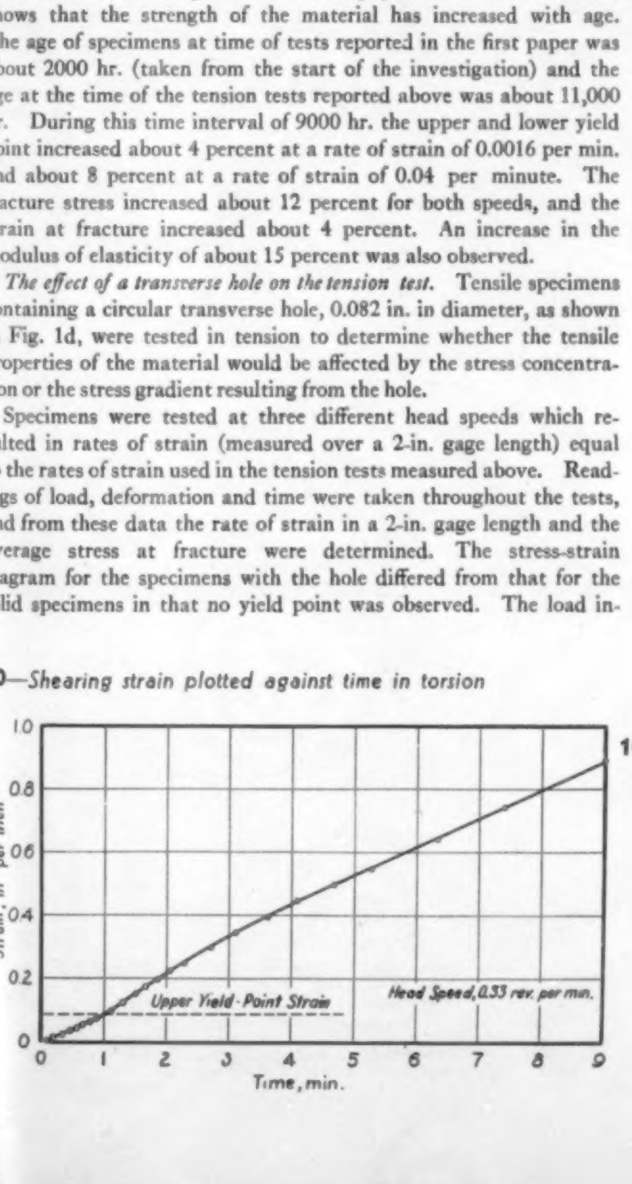

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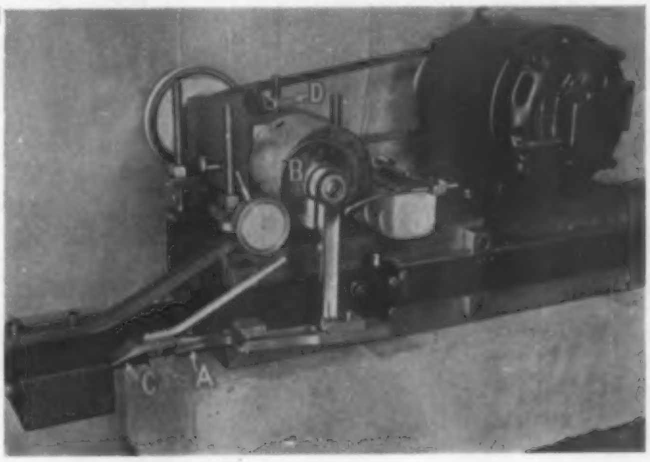
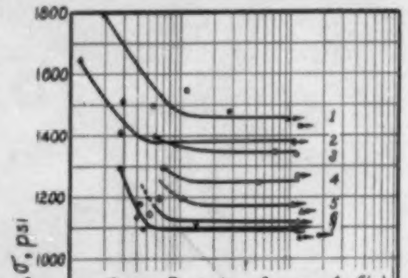


11—*Fatigue machine equipped with variable V-belt drive*

Fatigue tests

Fatigue tests were conducted on repeated constant-deflection type fatigue machines. These machines were equipped with a V-belt drive to provide variable speed as shown in Fig. 11. In this type of machine the specimen A was repeatedly bent back and forth as a cantilever beam by the variable eccentric B. Both horizontal and vertical adjustment of the relative position of the spindle of the machine and the specimen vise was provided to allow a variety of different tests. The procedure in conducting these tests was as

discussed in A.S.T.M. method D 671-42T.[6] In all cases the stress in the specimen was computed from the equation $\sigma = \frac{Mc}{I}$. The bending moment M was obtained for most of the tests by calibration of the specimen as a beam by means of dead weights. The deflection of the specimen under load was measured by means of a dial gage. In a few of the tests a dynamometer C, Fig. 11, was used for measuring the bending moment. The number of cycles to which the specimen was subjected was recorded on a counter D, Fig. 11, and a toggle switch was arranged to stop the machine when the specimen fractured. Thus for each specimen placed in the machine the stress corresponding to the deflection of the specimen during the test was calculated from the bending moment measured while the machine was at rest, and the number of cycles for fracture was obtained. These data were then plotted with stress as ordinates and number of cycles as abscissa using semi-logarithmic plotting. For the cellulose acetate a well-defined endurance limit was found.



12

12—Stress vs. cycles (σ — N) for tests of specimens having several different shapes

Effect of shape of specimen and age. In Fig. 12, $\sigma - N$ (stress vs. cycles) diagrams are plotted for tests of specimens having several different shapes: curve 1, a circular cross section specimen shown in Fig. 1k; curve 7, a rectangular specimen, Fig. 1f; curve 6, a square specimen, Fig. 1g of $^7/_8$ in. radius; and curve 4, a square cross section of 2 in. radius. The endurance limit for these tests is shown in the third column of Table I. It was found by re-tests of the same material after a lapse of time of a year and three months that the endurance limit increased with the age of the material. The $\sigma - N$ diagram for specimens aged 11,000 hr. is shown in curve 2 of Fig. 12. Comparing this endurance limit, 1380 p.s.i., with the endurance limit, 1100 p.s.i., for the same shape specimen tested 11,000 hr. earlier, it was found that the endurance limit of the material had increased about 25 percent in 11,000 hr. (about 15 months).

In order to compare data obtained at different periods of time, the endurance limit for the several shapes tested was adjusted approximately to the value which was obtained at an age of 11,000 hr. (measured from the time of the original test). The adjustment was made on the assumption that the change of endurance limit with time was nearly a linear function during the time interval considered. The age as defined above for each set of tests is shown in column 4 of Table I, and the endurance limit adjusted to an age of 11,000 hr. is shown in column 5.

[6] A.S.T.M. Tentative Method for Repeated Flexural Stress (Fatigue) Test of Plastics. 1943 Book of A.S.T.M. Standards, Part III, p. 1251; MODERN PLASTICS *20*, 95 (Dec. 1942). This method was prepared by Section C on fatigue and impact tests of plastics of which the author was chairman, and was based, in part, on experience gained by tests reported herein.

Comparing different shapes of specimens by means of column 5, it was found that the square specimen with $^7/_8$ in. radius had nearly the same endurance limit as the rectangular. The square specimen with 2-in. radius had a slightly higher endurance limit, an increase of about 4 percent, whereas the circular cross section specimen had an endurance limit markedly higher than any of the other two shapes, showing an increase of about 27 percent over the endurance limit for the rectangular specimen. The reason for this is not known. A similar effect has been observed in some metals and not in others. It may be associated, in part, with the quantity of material subjected to high stress, compared to the quantity of material immediately adjacent to high stress material which is available to receive additional stress, resulting from the redistribution of stress after a minute crack has formed.

The effect of molded surface. In order to determine the effect of the molded surface on the endurance limit of cellulose acetate plastic, about 0.025 in. was removed from both surfaces of rectangular specimens, Fig. 1f. The $\sigma - N$ diagram obtained for these specimens is shown in curve 5, Fig. 12. It was found that the endurance limit adjusted to an age of 11,000 hr., was about 2 percent higher for the machined surface than for the molded surface (see column 5, Table I). Apparently the molded surface has very little effect on the fatigue strength.

Effect of specimen temperature. In the first paper on cellulose acetate[1] it was shown that the temperature of the specimen during a fatigue test was a few degrees above room temperature. It was also shown that a blast of air from a low-pressure, high-velocity fan would reduce the specimen temperature nearly to room temperature. An endurance limit was obtained with specimens tested under an air blast of about 2500 ft. per min., under which conditions the temperature of the specimen as measured by a thermocouple taped to the top of the specimen was less than 1° above room temperature. The $\sigma - N$ diagram for these tests is shown in curve 3, Fig. 12, for a square specimen, Fig. 1g. The endurance limit for this test adjusted to age at 11,000 hr. was about 14 percent higher than the corresponding endurance limit obtained in still air (see Table I, column 5).

Effect of speed of testing. Five different endurance limits were obtained at various speeds of testing, ranging from a frequency of 42 cycles per min. to a frequency of 2900 cycles per minute. The $\sigma - N$ diagram for these tests are shown in Fig. 13. It will be appreciated that tests at 42 cycles per min. require an extremely long time to complete. The endurance limit of curve 8 is not quite as well defined as for the other curves in this series.

Figure 14 shows the effect of frequency on the endurance limit. In this curve the endurance limit is plotted against the test frequency. The circles represent the actual value of the endurance limit as obtained. The square plotted points represent the data corrected for the effect of aging on the basis of linear variation of endurance limit with time. For this series of tests the age effect was determined from a different set of tests than in the former. Curve

TABLE I.—ENDURANCE LIMITS FOR DIFFERENT SHAPED SPECIMENS

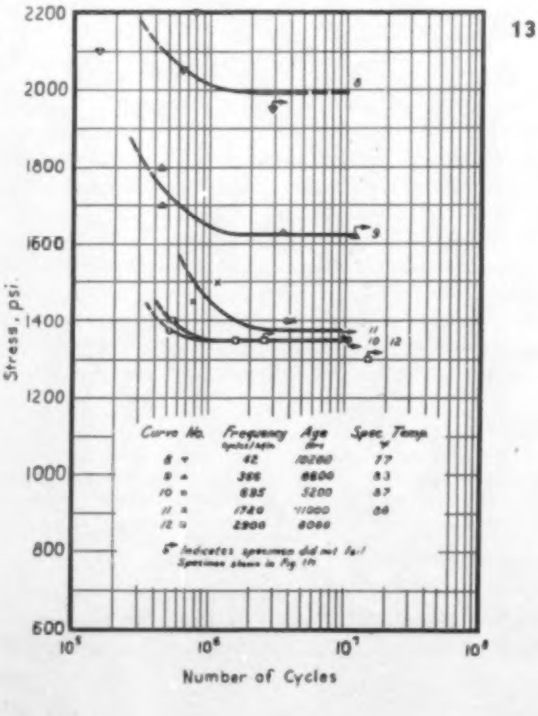
Curve No.	*Specimen*	*End limit (measured)*	*Age*	*End limit at age 11,000 hr. (calculated**)*
		p.s.i.	*hr.*	*p.s.i.*
1	Circular, Fig. 1k	1450	1,400	1760
2	Rectangular, aged, Fig. 1f	1380	11,000	1380
3	Const. temp., Fig. 1g	1350	4,400	1540
4	Square, 2-in. rad., Fig. 1h	1250	3,600	1440
5	Machined, Fig. 1f	1175	2,000	1410
6	Square, $^7/_8$-in. rad., Fig. 1g	1120	1,800	1350
7	Rectangular, Fig. 1f	1100	0	1380

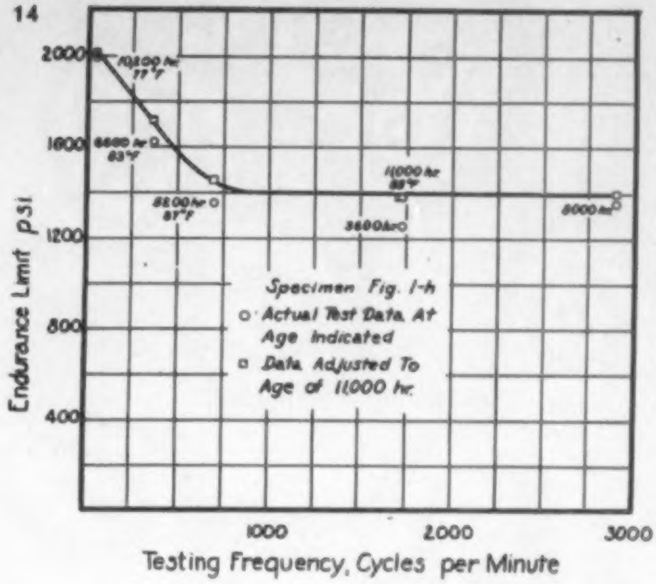
* These values were obtained by correcting all endurance limits to the value which would be found if tested at an age of 11,000 hours. The correction was based on an assumption that the endurance limit increased linearly with time. The rate of increase was found from curves 2 and 7.

11, Fig. 13, having an age of 8000 hr. corresponds with curve 4, Fig. 12, at an age of 3600 hr. The effect of age as obtained from this set of tests does not agree exactly with the effect of age in the previous tests. This may be due in part to the fact that humidity control of the laboratory was interrupted for a short time during the time interval covered by the first tests, or the difference may indicate that the effect of aging is not a linear function of time. The square plotted points shown in Fig. 14 represent the data adjusted to an age of 11,000 hr. It was found that the endurance limit markedly decreased with increasing testing frequency up to a frequency of about 750 cycles per minute. From there on to a frequency of about 2900 cycles per min. (the extent of tests reported) the endurance limit remained substantially constant. Thus for low frequency the magnitude of the frequency has an appreciable effect on the endurance limit, but above 750 cycles per min. the endurance limit is unaffected by change in frequency. The effect may in part be due to relaxation of stress during each cycle as a result of creep at the low frequencies of testing.

Effect of range of stress. All of the above mentioned endurance limits were obtained for completely reversed stress cycles. It was known that the resistance to repeated loading of some materials was influenced by the range of stress, so that it seemed desirable to study the effect of this variable. In this paper range of stress will be defined in terms of two quantities. A cycle of stress may be resolved into two components, a constant or *mean* value of bending stress, σ_M, and an *alternating* stress, σ_a, which is superimposed on the mean stress. For the previous set of tests the mean stress was zero, and the endurance limit was the magnitude of the maximum alternating stress which would not cause fracture after a large number of cycles. When the mean stress is not zero, the corresponding value of maximum alternating stress, σ_a, which will not cause fracture is here defined as the endurance limit of the material for that value of the mean stress. In Fig. 15 the maximum stress of the stress cycle for various values of the minimum stress of the cycle is plotted against the number of cycles required to cause fracture. The maximum stress was found to increase with increase in mean stress. However, when the endurance limit was plotted against the mean stress for different ranges of stress the diagram shown in Fig. 16 was obtained. Figure 16 shows that the endurance limit decreases with an increase in the mean stress of the cycle, when the mean stress is a tension stress. The ranges of stress shown are for tension mean stress, since it was found that the fatigue fracture originated on the tension side of the specimen.

13—σ — *N diagrams for several testing frequencies*





14—*Effect of "speed" of testing on the endurance limit*

It was found that during the test of a specimen the mean stress of the cycle decreased very rapidly during the first million cycles of the test (at a speed of 1750 cycles per min.). Thereafter the mean stress decreased very slightly with increase in number of cycles. This decrease in mean stress was due to relaxation as a result of creep under the action of the mean stress. In order to evaluate the effect of this relaxation on the diagram of Fig. 16, the value of alternating stress and mean stress which obtained at one million cycles was plotted as open circles in Fig. 16. It was found that the relaxation of stress did not materially affect the endurance limit vs. mean stress diagram. The data plotted in Fig. 16 were adjusted to an age of 11,000 hours.

Summary and conclusions

The following conclusions may be drawn from tests of cellulose acetate plastic conducted in a room maintained at a constant temperature of 77° F. and constant relative humidity of 50 percent.

1. A time of about one and one-half months was required for the compressive yield point and the weight to approach equilibrium in an atmosphere of constant temperature and relative humidity.
2. The yield point and fracture stress were found to increase with increasing rate of strain for tests in tension, compression, and torsion.
3. The modulus of elasticity in tension and torsion was found to be independent of the rate of strain for the values tested, but the modulus in compression was found to increase with increasing rate of strain for loading in compression. The following values of modulus were found: tension, $E = 244{,}000$ p.s.i.; torsion, $G = 78{,}000$ p.s.i.; compression, E varied from 204,000 to 278,000 p.s.i.
4. At a tensile rate of strain of 0.04 per min. the values of upper yield point were: tension, 4400 p.s.i.; torsion, 3300 p.s.i.; compression (long specimen), 4300 p.s.i. And the fracture stress was: tension, 5500 p.s.i.; torsion (modulus of rupture), 4900 p.s.i.
5. Aging of the material at constant temperature and relative humidity was found to increase the tensile strength about 4 to 12 percent and the modulus of elasticity in tension about 15 percent during a time of about one year.
6. A transverse hole in a static tension specimen was found to reduce the ultimate elongation in 2 in. to about 8 percent of the elongation in a solid specimen. The ultimate strength (based on the net area) was found to be about 10 percent less for a specimen with a hole than for the solid specimen.
7. Fatigue tests showed that the endurance limit, obtained by computing stress from the flexure formula, varied with the shape of the specimen.
8. Aging of the material was found to increase the endurance limit about 25 percent in a period of 15 months.
9. The endurance limit of the (*Please turn to page 138*)

Long-time tension test of plastics

Scope

1. (*a*) This recommended practice covers the determination of the amount of extension of plastics due to the combined effects of tensile stress, time, temperature and relative humidity, when tested in the form of specimens of standard shape.

(*b*) The details of this recommended practice are largely advisory, since the characteristics of a plastic as to its resistance to extension are not well known. For reference or comparative tests of any given series of materials or specimens care shall be taken to secure the maximum degree of uniformity in details of preparation, treatment and handling.

Definitions

2. (*a*) *Ultimate* (*or tensile*) *strength* of a plastic is the tensile load per unit area of original cross section, expressed in pounds per square inch, required to break a test specimen within the gage boundaries in accordance with the Tentative Methods of Tension Testing of Plastics (A.S.T.M. Designation: D 638) of the American Society for Testing Materials.[1]

(*b*) *Elongation* is the change in length expressed in inches produced by a tensile load on a longitudinal section of a test specimen measured between fixed gage points on the specimen.

Apparatus

3. The apparatus should consist of the following:

(*a*) *Testing machine.* Any simple suspension device by means of which a predetermined load accurately measured to within 1 percent may be applied in tension as dead weight loading or by the use of a simple lever system. The test system should be as free from vibration as possible.

(*b*) *Grips.* Grips for holding the test specimens. Grips of the form shown in Fig. 1 are satisfactory. These grips may be made from any noncorroding metal.

(*c*) *Extensometer.* A suitable instrument for determining the distance between two fixed points on the test specimen gage length at any time during test. Dividers may be used, since it is essential not to disturb the original position of the specimen to obtain the change in position of the fixed lines on the gage length. A cathetometer or electrical resistance device will yield more accurate results wherever these can be employed.

Classifications of materials

4. Plastics shall be arbitrarily divided into four groups on the basis of ductility and rate of response to variations in atmospheric temperature and humidity, as follows:

Class A (*low and rapid*). Those materials whose ultimate percentage elongation as determined in accordance with Tentative Methods D 638[2] is 5 percent or less, and whose impact strength as the result of variations in atmospheric humidity or temperature changes sufficiently during the period of time required for the completion of a tension test to affect numerical test results by 10 percent.

Class B (*low and slow*). Those materials whose ultimate percentage elongation as determined in accordance with Tentative Methods D 638[2] is 5 percent or less, and whose impact strength is so slowly affected by variations of atmospheric humidity or temperature that numerical test results do not change by as much as 10 percent during the period of time required for completion of a tension test.

Class C (*high and rapid*). Those materials whose ultimate percentage elongation as determined in accordance with Tentative Methods D 638[2] is over 5 percent, and whose impact strength as the result of variations in atmospheric humidity or temperature changes sufficiently during the time required for completion of a tension test to affect numerical test results by 10 percent.

Class D (*high and slow*). Those materials whose ultimate percentage elongation as determined in accordance with Tentative Methods D 638[2] is over 5 percent, and whose impact strength is so slowly affected by variations in atmospheric humidity or temperature that numerical test results do not change by as much as 10 per cent during the period of time required for completion of a tension test.

NOTE. It is recognized that this basis of classification is a very arbitrary one and that behavior in the impact test is not necessarily the criterion of the behavior in the tension test. The classification has, however, been adopted by a joint action of A.S.T.M. Committee D-9 on Electrical Insulating Materials and Committee D-20 on Plastics and is retained here until such time as a more suitable classification can be developed.

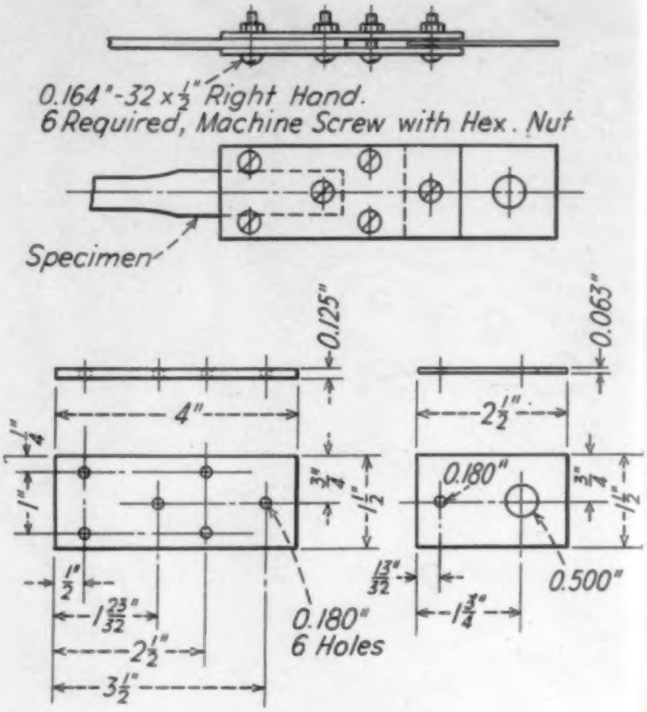
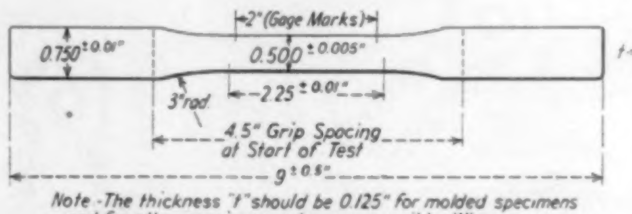


Fig. 1—*Grips for test specimen*



Note - The thickness "t" should be 0.125" for molded specimens and for other specimens wherever possible. When specimens are machined from sheet materials, thickness may be the thickness of the sheet provided this does not exceed 0.5".

Fig. 2—*Tension test specimen*

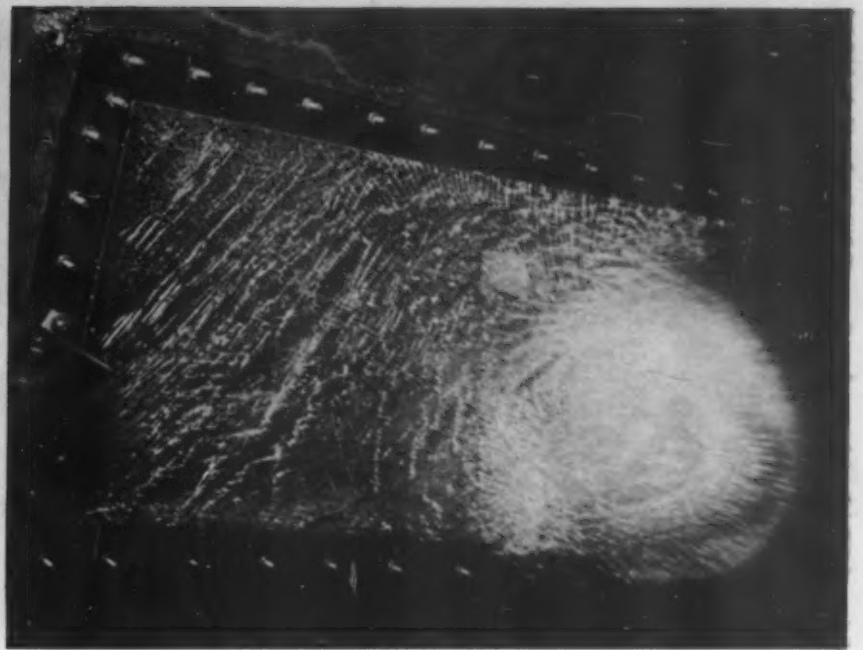
Test specimens

5. (*a*) The test specimens shall conform to the dimensions shown in Fig. 2. The specimens may be injection or compression molded or machined from sheets, plates, slabs or similar material.

(*Please turn to page 144*)

[1] This tentative method for Long-Time Tension Test of Plastics, A.S.T.M. designation D 674 – 42T, is published here by permission of the American Society for Testing Materials.
[2] 1942 Book of A.S.T.M. Standards, Part III.

1



2

1—*Test windshield panel mounted in test frame with velocity measuring grid.* 2—*Rear of glass-vinyl plastic laminated windshield panel during impact, showing glass splinters thrown off rear face*

Impact-resistant aircraft windshields

by G. L. PIGMAN*

IN keeping with the many rapid developments in the aeronautical field during the past several years, a variety of problems associated with aircraft windshields has recently been brought to the forefront and attacked by the aircraft industry and by various development groups. Such development has been instigated as a result of the greater need felt for adequate visibility and protection for the pilots of large modern transport aircraft of high speed, and because of the improved glass and plastic materials and methods of fabrication which now are available and which offer the promise of solution of various aspects of the windshield problem which long have been recognized.

The two present principal hazards to safe flying which are associated with windshield design and for which the aircraft industry desires immediate solution are:

1) Accretion of ice on the windshield which may result in a complete loss of vision to the pilot, and

2) Penetration of the windshield panel by collision with birds in flight, which may result in blinding the flight personnel or seriously injuring them. Numerous injuries have been sustained as a result of accidents caused by ducks, wild geese, eagles, seagulls and other birds, crashing through the windshield into the cockpit enclosure. Birds (weighing as much as 15 lb.) have been encountered at varying heights up to 8000 feet. They are a constant source of worry to pilots, particularly when flying at night. In several instances the birds also have penetrated the bulkhead, have traveled the length of the cabin, and have penetrated the rear wall.

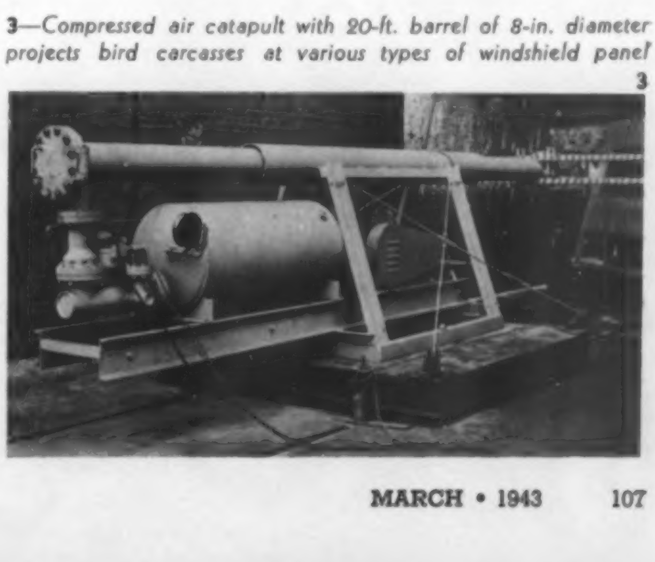
In addition to overcoming these hazards, it is essential to retain and improve the optical properties of the windshield with regard to distortion and reflections in any heavier or more complex windshield arrangements which may be required in the solution of the more immediate problems. There also is being considered seriously, at the present time, the necessity for incorporating in windshields materials which will absorb the ultraviolet and infrared radiations which may be encountered in sufficiently great intensities at high altitudes to cause serious discomfort or injury to the cockpit crew. It is evident that the windshield problem is complex: all of these various factors must be considered, as well as the weight of the installation, in any satisfactory solution which may be offered. Any final solution, therefore, probably will be a compromise among the various aspects of the problem.

Because of the immediate need for adequate windshield de-icing and bird collision protection, the Civil Aeronautics Administration has initiated a development program which will lead to a practical solution of these problems for present transport aircraft. A test setup has been made at the Westinghouse Electric & Manufacturing Co. at East Pittsburgh, Penna., in which a compressed air catapult is utilized to project freshly killed bird carcasses weighing from 4 to 16 lb. at velocities up to 400 mi. per (*Please turn to page 150*)

* **Aeronautical engineer, Aircraft Development Section, Civil Aeronautics Administration.**

3—*Compressed air catapult with 20-ft. barrel of 8-in. diameter projects bird carcasses at various types of windshield panel*

3



Synthetic rubber[1]

by HOWARD I. CRAMER[2]

WE are faced with a real emergency with regard to the supply of elastomers available during the war period. It is necessary that the present 400,000 long tons of natural rubber in this stockpile be not consumed below 120,000 long tons. Rubber and synthetic materials constitute the proverbial horseshoe nail in our war economy, and there are certain emergency steps which we must take to meet our rubber requirements.

Japan, by conquering certain territories in the East Indies, has acquired the source of over 90 percent of the natural crude rubber supply. Three and nine tenths percent of this supply comes from South America and Africa. Some 7 percent is produced in Ceylon and British India, but the highest concentration of natural rubber occurs in Malay and North Sumatra.

Prior to the war, we used from 450,000 to 600,000 long tons of rubber, or one-half of the total world consumption; but in 1941, when we anticipated the present emergency, we imported 725,000 long tons of rubber during the year.

What steps can be taken to increase the supply of available rubber for our present use? For one thing, we can increase production in the remaining acreage.

The Rubber Reserve Company has provided funds whereby the production of wild rubber in South America is being increased, and in 1944 the estimated production will be 70,000 long tons. We will, however, receive only that which remains after the requirements of South American factories have been met. In Mexico and the southern United States, there normally are obtained from the guayule plant about 5000 tons of rubber a year. Congress appropriated funds in March and October of 1942 to provide for plantations in the southwestern United States which will eventually reach 500,000 acres.

The program will level off with the annual harvesting of 180,000 acres a year to give 80,000 to 100,000 long tons of guayule per annum. In Africa, there will be produced 10,000 to 15,000 long tons of wild rubber annually, which will go to Great Britain. In addition, the Firestone company produces some 15,000 tons of natural rubber in Liberia, which formerly came in as latex.

We normally produce 200,000 tons per year of reclaimed rubber from scrap, but under the present emergency, this will be raised to 350,000 tons.

The above methods for increasing our supply of rubber are but stop-gap expedients, and are not adequate to fill our needs. The problem can be solved only by an increased production of quality synthetic rubber in a minimum time.

We still have no true synthetic rubber. What we produce are simply synthetic, rubber-like materials, none of which possesses all of the unique properties of the natural product. Why do we not know more about rubber, when so much study has been put on the subject? The answer lies in the type of molecules. In the case of the rubber molecule, it is extremely difficult to purify. We do not know the molecular weights, so the problem is quite complicated from the molecular standpoint.

Properties of synthetic and natural rubbers

Synthetics are superior in:

1. Resistance to deterioration by oils and organic solvents
2. Resistance to oxidation or aging
   a. From actinic rays
   b. From heat
   c. From strong oxidizing agents (Butyl rubber outstanding)
3. Lower permeability to gases

Natural rubber is superior in

1. Processing properties
   a. Power consumption
   b. Calendering and tubing
   c. Building tackiness
2. Resiliency
3. Resistance to flexing
4. Tendency to stiffen at low temperatures

The compounding art has developed at this time to the point where we feel quite sure that satisfactory tires and tubes may be manufactured from Neoprene, from the butadiene types of rubber and from Butyl Rubber. In the case of the latter two types of synthetics, one of the principal problems, particularly in the case of heavy-duty tires, is to compound the rubber to overcome the tendency of the tire to generate excessive heat in the carcass. The present indications are that synthetic tires will be comparable with, and under certain conditions superior to, natural rubber in abrasion resistance, i.e., road-wear.

Price comparisons

Natural rubber has varied in price from $1.25 a pound to less than 3 cents. The Government has pegged the rubber in our stockpile at 23 cents, which was the current price just before the war.

The cost per pound of producing synthetic rubber varies according to the type: Buna S, 50 cents; Hycar OR, 70 cents; Polybutene, 41 cents; Neoprene, 65 cents; Buna N, 70 cents; and Thiokol, 50 cents. Without question the price of all the synthetics will be reduced, particularly when the production volume increases. It is expected that Buna S can be produced at from 15 to 20 cents per pound, and Butyl from 10 to 15 cents per pound.

Uses of various synthetics

Buna S is best in tires and tubes, etc. Guayule added to Buna S improves it.

Buna N is best in products where oil resistance is important.

Thiokol is outstanding for oil resisting properties and present indications are that it will be used for recaps.

Koroseal is good for specialty goods, insulated wire, etc.

The polyvinyls are used to coat fabrics.

Consumption of natural rubber

In normal times, tires and tubes and repairing use 76 percent.

Industrial rubber goods take 10 percent.

Boots and shoes use 7 percent.

Drug sundries require 5 percent.

Miscellaneous uses, 2 percent.

Some specific rubber requirements

Gas masks require 2 pounds of rubber.

Pneumatic rafts, 29 pounds.

Army trucks, 500 pounds.

Bullet proof gas tanks for Flying Fortress, 1200 pounds.

Medium tank, 1730 pounds.

Ten-ton pontoon bridge, 3200 pounds.

Battleship (35,000 tons) requires 150,000 pounds.

Rubber balance sheet—Baruch report

	Long tons
Stockpile, July 1942	578,000
Imports July 1942 to Jan. 1944	53,000
	631,000
Requirements	
Estimated military and other essential demands	842,000
Deficit to be met by synthetic rubber program	211,000

(*Please turn to page 142*)

[1] A summary of a talk before a meeting of the New York Chapter of the American Institute of Chemists, Jan. 29, 1943, at the Chemists' Club, New York, N. Y.

[2] Sharples Chemicals Corp.

TECHNICAL BRIEFS

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments

Engineering

PLASTEL—A NEW METHOD OF INCREASING FLEXURAL STIFFNESS. N. A. de Bruyne. British Plastics *14*, 306–316, 349 (Nov. 1942). Stainless steel strips are stabbed regularly with small burred holes and the reentrant edges of these holes engage with the plastic so that the metal and plastic are regularly locked together. The metal-plastic composite has the advantages of greater flexural stiffness, increased resistance to abrasion and heat and improved dimensional stability under varying conditions of temperature and humidity. The combination is also useful in radio sets for chassis and screening panels and for various electrical uses.

FABRICATING PLASTIC DYES FOR ACRYLATE SHEETS. K. J. Leeg. Aviation *41*, 143–5, 335–6 (Nov. 1942). Cast phenolic resin containing 25 percent walnut shell flour is recommended for making dies for forming acrylic resin sheets. They are superior to those made of plaster of Paris, of metal and of hardwood. One of the valuable properties of this material for this application is the low rate of heat transfer.

TRANSPARENT PLASTIC MODELS. Automotive and Aviation Ind. *87*, 44, 96 (Dec. 1, 1942). The experiences of an English firm in making transparent plastic models to facilitate design and research are described. Several of the models made by this firm are illustrated.

INSULATING WOOD. A. E. L. Jervis. Elec. Rev. *131*, 581–3 (Nov. 6, 1942). The results of electrical, mechanical and chemical tests made on "Insul-Jabroc" are given. See MODERN PLASTICS for December 1942, page 100, for information on the related material "Jabroc."

Chemistry

FORMATION OF SYNTHETIC RESINS FROM SCHIFF'S BASES. I. RESINS FROM SULFONIC ACID AMIDES AND FORMALDEHYDE. W. Scheele and L. Steinke. Kolloid-Z. *97*, 176–89 (1941). Observations were made on the resinification of mixtures of *p*-toluenesulfonamide and methylene-*p*-toluenesulfonamide with formaldehyde. Mixtures containing more than 70 percent *p*-toluenesulfonamide did not give resins. Resins rich in methylene-*p*-toluenesulfonamide showed a tendency to crystallize when heated slowly. The most stable resins contained equal mols of *p*-toluenesulfonamide and methylene-*p*-toluenesulfonamide and were clear and colorless. Increasing the amount of methylene-*p*-toluenesulfonamide resulted in the formation of yellow and the red-brown resins. Softer resins of low viscosity were obtained by increasing the amount of *p*-toluenesulfonamide.

STRUCTURE OF SYNTHETIC CHAIN POLYMERS AS SHOWN BY X-RAYS. C. S. Fuller and W. O. Baker. J. Chem. Education *20*, 3–10 (Jan. 1943). A review of the present concepts concerning the structure of synthetic chain polymers as revealed by x-rays is given.

Properties

FATIGUE RESISTANCE OF FLEXIBLE PLASTIC SHEETING. F. W. Duggan and K. K. Fligor. Ind. Eng. Chem. *35*, 172–6 (Feb. 1943). The fatigue life of flexible vinyl resin sheeting is from 30 to 200 times longer at room temperature (25° C.) than at freezing temperature (0° C.). The flexing of folded samples is no more severe than simple flexing of flat sheetings, provided they are both bent to the same radius at the crease during flexing and that this radius is 0.045 in. or greater. The alternating of tension with flexing reduces the fatigue life of a sheeting in proportion to the degree of stretch imposed. Press-polished sheeting has 2 to 3 times the fatigue life of sheeting with a matte finish (sharp irregularities in the surface). The type of resin used in the sheeting is an important determinant of its fatigue life. Of the vinyl resins studied, W (a high molecular weight copolymer) provided sheetings with the greatest resistance to fatigue. In a series of flexible vinyl sheetings prepared from a given base resin, the fatigue life increases rapidly with increase in plasticizer concentration. A compound containing 40 percent plasticizer will have from 2 to 20,000 times the fatigue life of a compound containing 20 percent plasticizer. If only those plasticizers which are readily compatible with the resins involved are considered, and if comparisons are made on compounds of equal flexibility, the type of plasticizer used in the sheeting has little effect on fatigue life. Fillers greatly reduce the fatigue life of flexible sheetings prepared from copolymer resins. However, sheetings prepared from polyvinyl butyral appear to be reinforced by the inclusion of certain fillers.

EFFECT OF CONDITIONING UPON SOME PHYSICAL PROPERTIES OF UREA-FORMALDEHYDE MOLDINGS. J. Horton. British Plastics *14*, 377–380 (Dec. 1942). Data are presented regarding the effects of heating at 100°, 150° and 212° F. for periods up to 4 weeks on the impact strength, flexural strength, water absorption, breakdown voltage and surface resistivity of urea-formaldehyde moldings. A similar study was made of the effects of immersion in water at 60° to 68° F. for 4 weeks on the mechanical and electrical properties of this plastic. The loss in flexural strength of the cellulose-filled plastic at 212° F. was about 25 percent, whereas there was no deterioration in impact strength in 4 weeks at that temperature. Soaking in water causes both flexural and impact strength to decrease 20 to 25 percent in 4 weeks. Heating improved the electrical properties.

MECHANICAL PROPERTIES OF PLASTICS AT LOW TEMPERATURES. Plastics *6*, 439–442 (Dec. 1942). Recent investigations in Germany on the compression properties of phenolic, urea, methyl methacrylate, polyvinyl chloride and polystyrene plastics at 18°, 0°, −40° and −70° C. are described. The compression properties investigated were modulus of elasticity, yield point and relationship between plastic deformation and total deformation.

ELECTRIC CABLE INSULATION FROM SYNTHETIC RUBBERS. S. E. McCrary, R. P. Metcalf, J. B. Lunsford, H. K. Graves, T. A. Werkenthin, R. E. Morris and R. R. James. India Rubber World *107*, 157–62, 170 and 265–71 (Nov. and Dec. 1942). The results of experimental work dealing with the compounding and curing of natural rubber and eleven synthetic rubbers for use in 40 percent cable insulation are presented. The materials were examined for appearance, odor, specific gravity, tensile strength, ultimate elongation to rupture, tensile modulus at 200 percent elongation, permanent set, crescent tear, hardness, deterioration resulting from exposure to light, heat, oxygen, organic solvents, sea water and sulfuric acid, compression, bonding, abrasion resistance, flow, flexing endurance, flexing at low temperature, thermal conductivity, flammability, moisture absorption, corrosion of copper, dielectric strength, dielectric constant, power factor and insulation resistance. A test program is proposed for determining the permanence of an insulating material.

LOW TEMPERATURE SYNTHETICS. P. A. Anderson. Aero Digest *41*, 184, 279 (Dec. 1942). Flexibility at −70° F. is needed for substratosphere and stratosphere flying. Testing methods and experience with some synthetic rubbers are described.

THE EXTENSION AND RUPTURE OF CELLULOSE ACETATE AND CELLULOID. R. N. Haward. Trans. Faraday Soc. *38*, 394–403 (Sept. 1942). The extension and rupture of cellulose acetate and cellulose nitrate were measured and the results explained on the assumption that the two processes are largely independent. The significance of the various equations derived is discussed. It is shown that materials with high impact strength extend suddenly and quickly under high stresses which are not sufficient to cause rupture.

PLASTICS DIGEST

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals mentioned directly to publishers

General

RAW MATERIAL SUPPLIES FOR PLASTICS MANUFACTURE. Ralph H. Ball. Chem. and Eng. News *21*, 73–6 (Jan. 25, 1943). Our problem of maintaining supplies of plastics to meet war needs is as much one of insufficient plants for the synthesis of the resins and plastics themselves as of basic chemical shortages. Our major material shortages are phenol, cresols and furfural for the tar acid resins; benzene for polystyrene; nitric acid for cellulose nitrate; and phenol and cresol for triphenyl phosphate and tricresyl phosphate plasticizers. Other shortages and threatened shortages are ammonia for urea, cotton linters for the cellulose esters and phthalic anhydride and octyl alcohol for phthalate plasticizers.

IMPROVED TECHNIQUES PROMOTE EXPANDED USE OF PLASTIC PARTS. Kenneth Woodson. Aero Digest *41*, 126, 276 (Dec. 1942). Zinc alloy molds made by casting instead of machining have proved practical for short runs in plastic molding. The Consolidated B-24D airplane uses more than 300 molded plastic pieces and almost 1500 laminated phenolic pieces, such as pulleys, fairleads and spacing blocks. The development of a thermos jug drain tray and a throttle quadrant in plastic material are discussed. The cost differential in converting to plastic from metal is an important consideration in the system set up by Consolidated for surveying their requirements. This includes the cost involved in scrapping dies and fixtures already made for the forming of metal parts.

WHAT THE PRODUCT DESIGNER SHOULD KNOW ABOUT PLASTICS. Erik Furholmen. Machinery *48*, 141–4 (Mar.); 199–203 (Apr.); 140–5 (May); 140–4 (June); 148–51 (Aug. 1942). The following subjects are discussed: reasons for choosing plastics; dimensional limitations; various types of molding processes; types of molds used in compression molding; injection molding; and cold molding. Molded plastics are especially adapted for use where one or more of the following conditions must be met: (1) a dielectric is required, (2) molding is economical, (3) elimination of an applied finish is essential, (4) colors are advantageous, (5) transparency or translucency is desired, (6) minimum weight is required, (7) high degree of corrosion resistance is important, (8) low heat conduction rate is advantageous, (9) wear resistance is important and (10) a considerable degree of resilience is wanted. Twenty-seven general rules to be followed in designing plastic parts are given. Many specific points in plastic part design are discussed and illustrated. Advice is given relative to the use of metal inserts and the location of push-out pins, ribs, bosses and louvers. The effects of humidity and temperature variations, of molding conditions and preconditioning of the molding materials are discussed. The effect of creep or cold flow on dimensional tolerance is also pointed out. Design is considered from the viewpoint of the appearance of and finishing operations necessary on the molded product.

A SCHEMATIC PROCEDURE FOR IDENTIFICATION OF COMMON COMMERCIAL PLASTICS. H. Nechamkin. Ind. Eng. Chem. Anal. Ed. *15*, 40–1 (Jan. 1943). The types of flame obtained and the odors generated by burning some common commercial plastics are described. These data are arranged in a schematic form to assist in identifying the various plastic materials.

Materials

SUBSTITUTION AMONG MATERIALS USED FOR CABLE INSULATION. H. Barron. Gen. Elec. Co. J. *12*, 71–83 (Aug. 1942). The use of plastics and synthetic rubbers in the field of cable insulation are discussed. The properties of these materials which make them useful in this field are emphasized.

NON-CORROSIVE MATERIALS. Rayon Textile Monthly *23*, 729–32 (Dec. 1942). A general review of the properties of the common commercial plastics. The strength characteristics of 6 paper, 4 fabric and 2 asbestos laminated phenolic plastics are listed. The uses of plastics in the textile industry are emphasized.

POLYMERIZATION IN A PRECIPITATING MEDIUM. E. Jenckel and S. Süss. Naturwissenchaften *29*, 339 (1941). Styrene was polymerized in the presence of benzene, a solvent and ethyl alcohol, a non-solvent, respectively. The molecular weights of the resins formed in the two media as determined by the viscosity were the same, namely: at 140°C. 53,100; at 170°C. 29,600; at 200°C. 22,500. It was concluded that the solvent power of the polymerization medium has no effect on the molecular weight of the product formed.

Applications

REFRIGERATOR CARS OF PLYWOOD H. A. Dodge. Railway Age *114*, 246–8 (Jan. 23, 1943). Railroad refrigerator cars made of plywood have been in service since 1935. The plywood is used for general all-over construction. A brief description of the manufacture and conditioning of the plywood is given. Some of the advantages claimed for the plywood in this application are: 1) low heat conductivity, 2) fewer joints in construction, 3) low vapor transmission, 4) uses less nails and screws, 5) less dead haul weight, 6) worn or damaged plywood panels easily repaired and 7) low cinder leakage.

PLYWOOD IN AIRCRAFT CONSTRUCTION. G. A. Allward. Mechanical Eng. *65*, 14–16 (Jan. 1943). A general review of plywood and its use in aircraft construction. The points discussed include: 1) the types of veneers and their selection, 2) glues and gluing technique, 3) where plywood may be used most advantageously as a structural material in aircraft and 4) the weathering properties of plywood. Plywood is superior to metal in the following properties: 1) resistance to fatigue, 2) lack of creep, 3) resistance to corrosion, 4) stiffness and 5) low density. Resin-bonded plywood, instead of being a temporary substitute for metal, promises to become a keen competitor in aircraft construction.

DEMINERALIZING SOLUTIONS BY A TWO-STEP ION EXCHANGE PROCESS. H. L. Tiger and S. Sussman. Ind. Eng. Chem. *35*, 186–92 (Feb. 1943). With the advent of the acid-regenerated organic cation exchangers, it became possible to replace all metallic cations with hydrogen ions, leaving only the corresponding acids in solution. Various classes of organic cation exchangers have been developed: coal derivatives, lignite derivatives, materials made from paper waste and acid sludge, and resins such as tannin-formaldehyde and other polyhydric phenol-formaldehyde derivatives. Other materials, such as the aliphatic amine resins, have been developed which absorb the resultant free acids. They can be regenerated and operated indefinitely in repeated cycles like the cation exchangers. The principles of operation with these exchangers are discussed and information regarding equipment, applications and costs is given.

CONSERVATION OF METAL AND RUBBER BY CELLULOSE SHEETINGS. A. F. Wendler. Paper Trade J. *115*, 34–6 (Dec. 3, 1942). The shortages of metal and rubber have resulted in the extensive use of cellophane and combinations of cellophane and paper products to package foodstuffs. The outstanding characteristics which are responsible for their successful use are: 1) high impermeability to moisture vapor and gas, 2) grease and oilproofness, 3) high strength and flexibility, 4) large area factor per pound, 5) availability in a wide variety of types to fulfill the requirements of specialized users. The advantages obtained by using these materials to package frozen foods, cheese, frozen eggs, coffee, dehydrated foods, emergency rations and foods formerly sold in cans are explained. The cellophane containers are made in three general types: 1) a cellophane bag suspended in a can or box, 2) containers made of cellophane laminated with fiber and 3) multiwall bags.

ACTION OF STRONG ACID ON VARIOUS FIBERS. H. C. Haller. Am. Dyestuff Reporter *31*, 681 (Dec. 21, 1942). The effect of 70 percent sulfuric acid on various fibers, including some synthetics, are reported. Vinyon and saran are the only ones reported to undergo "no visible change."

COTTON PULPS. III. EFFECTS OF SUPPLEMENTARY MATERIALS ON BEATING. D. M. Musser and H. C. Engel. Paper Trade J. *115*, 33–5 (Aug. 20, 1942). The beating of cotton and wood pulps with methylcellulose and formaldehyde resulted in a decrease in the beating time and an increase in sheet strength. The higher viscosity methylcelluloses are more effective than lower viscosity materials.

Coatings

INFLUENCE OF MEASUREMENTS ON DEVELOPMENT OF MAGNET WIRE. F. P Wilson, Jr., and J. A. Weh. Gen. Elec. Rev. *45*, 612–14 (Nov. 1942). The latest methods used for testing wire covered with vinyl formal resin enamel are described. The tests include those to determine copper stiffness, appearance and color of the enamel film, wire dimensions, film thickness, film concentricity, film toughness shown by flexibility, heat-shock resistance and abrasion resistance, adhesion of film to wire, plastic flow of enamel, inertness to solvents, etc., inertness to chemicals, inertness to heat aging, dielectric breakdown and film continuity.

SYNTHETIC COATINGS PROTECT ENGINE PARTS. Aviation *41*, 169 (Dec. 1942). Polyvinyl alcohol resin is used to coat metal baskets, trays and racks for handling metal parts. The resilient coating protects the carriers and the metal parts during degreasing and transporting operations.

Molding and fabricating

MACHINING LAMINATED PHENOLIC PLASTICS. F. P. Hunsicker. Machinery *49*, 197–200 (Dec. 1942). Information on the punching, shearing, turning, sawing, drilling, tapping, threading, milling and buffing of laminated phenolic plastics is given in detail.

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U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each

COLORED ARTICLES. E. Wainer (to Titanium Alloy Mfg. Co.). U. S. 2,304,754, Dec. 8. An article which reflects yellow light and transmits blue light is made of a transparent organic plastic pigmented with 0.01 to 0.5 percent of a white pigment.

CELLULOSE MIXED ESTERS. L. W. Blanchard, Jr. (to Eastman Kodak Co.). U. S. 2,304,792, Dec. 15. Making cellulose acetate propionate or acetate butyrate by esterification in presence of sulfuric acid, between 70° and 90° F.

EXTRUDED SHEETING. F. R. Conklin and J. S. McLellan (to Eastman Kodak Co.). U. S. 2,304,886, Dec. 15. Extruding hot tacky thermoplastic sheets onto a moving cooling surface from which they are stripped after cooling.

VINYL INTERPOLYMERS. H. Hopff and C. W. Rautenstrauch (to General Aniline and Film Corp.). U. S. 2,304,917, Dec. 15. Emulsion polymerization of a vinyl compound or vinylidene chloride with propargyl alcohol, methylbutynol or 1,4-butynediol.

COLOR FILM. L. D. Mannes and L. Godowsky, Jr. (to Eastman Kodak Co.). U. S. 2,304,939–40, Dec. 15. Photographic film made up of photosensitized cellulose ester layers interspersed with gelatin layers, each cellulose ester layer containing an alkali-soluble color former; and films made from dispersions of water-insoluble but water-permeable cellulosic compounds in photosensitized emulsions.

BRASSIERES. A. B. Snowdon (to Celanese Corp. of America). U. S. 2,304,989, Dec. 15. Shaping a thermoplastic cellulose derivative fabric, then molding and shrinking it to the final shape and size.

INTERPOLYMERS. H. Hopff and C. W. Rautenstrauch (to Jasco, Inc.). U. S. 2,305,007, Dec. 15. Emulsion interpolymerization of butadiene with propene or a butene.

SURFACE COVERINGS. W. W. Durant (to American Cyanamid Co.). U. S. 2,305,215–6–7, Dec. 15. Curing drying oils or drying oil, modified alkyd resins (for floor or wall coverings) with the aid of cyanamide, melamine, ammeline or a guanamine.

METAL CONTAINERS. D. G. Patterson (to American Cyanamid Co.). U. S. 2,305,224, Dec. 15. Coating metal containers with an odorless, tasteless resin formed by modifying a glycol-maleic acid type alkyd resin with a diallyl ester.

SNAP FASTENERS. Nathan and Max Sloane. U. S. 2,305,277, Dec. 15. Forming the socket of snap fasteners from a plastic which is highly resilient but thin enough to be punctured by a needle.

CASTINGS. G. B. Taylor (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,305,362, Dec. 15. Casting superpolymer melts into voidless shaped articles in presence of an inert gas.

CRYSTAL-CONTAINING RESINS. O. Hansen (to Alexine Novelty Corp.). U. S. 2,305,417, Dec. 15. Making ornamental products of phenolic resin by forming crystals from phthalic anhydride in an alkaline medium while the resin is forming.

HOLLOW ARTICLES. Colin Kyle (to Jesse B. Hawley). U. S. 2,305,433, Dec. 15. Molding hollow shapes on a smooth hollow metal shell.

MILK BOTTLE CAP. J. F. Price (to Oswego Falls Corp.). U. S. 2,305,494, Dec. 15. Moistureproofing the upper face and portions of the under face of milk bottle caps with a thermoplastic resin.

MINERAL WOOL FELT. H. T. Coss, W. H. MacAlpine and H. V. Swindell (to Johns-Manville Corp.). U. S. 2,305,516, Dec. 15. Making insulating felts from mineral wool and a thermoplastic binder which is hardened while the felt is compressed.

SLIDE FASTENERS. J. Kuna (one-half to Brevetia Ltd.). U. S. 2,305,623, Dec. 22. The interlocking member of a sliding clasp fastener has two complementary parts made of a plastic composition.

METHACRYLATES. Ludwig Beer and Paul Halbig (vested in the Alien Property Custodian). U. S. 2,305,663, Dec. 22. Making methyl methacrylate by dehydration of methyl 2-methyl-3-hydroxypropionate.

LAMINATED FLOOR COVERING. E. Bentz, H. Burck, F. Heinrich, J. Jaenicke, H. Miedel, H. Knoop and O. Schweitzer (vested in the Alien Property Custodian). U. S. 2,305,804, Dec. 22. Covering a floor with a hydraulic cement containing a synthetic resin, then applying rolled plates of vinyl resin interlayer and ceramic tile as the floor surface.

SAFETY GLASS. A Kämpfer (vested in the Alien Property Custodian). U. S. 2,305,827, Dec. 22. Resinifying a vinyl ester in presence of a glycol ester or ether, a triaryl phosphate or the like.

SHAPED ARTICLES. Ernst Freund (to Gemloid Corp.). U. S. 2,305,859, Dec. 22. Forming hard shaped articles from a vinyl resin, adding a swelling agent and a plasticizer, and removing the swelling agent.

PLASTICIZER. Rudolf Endres (vested in the Alien Property Custodian). U. S. 2,305,920, Dec. 22. Plasticizing cellulose esters or ethers with tetrahydrofurfuryl esters of aliphatic ether-acids having at least 6 carbon atoms in the alkoxy group.

OPTICAL PRISMS. F. P. Williams and C. V. Smith (to Univis Lens Co.).U. S. 2,305,945, Dec. 22. Forming resinous blanks into prisms in contact with optically smooth glass surfaces.

ELECTRICAL RESISTOR. G. E. Megow and H. G. Thomson (to Allen-Bradley Co.). U. S. 2,305,977, Dec. 22. Making resistors from a hardened plastic and a powdered conductor.

MOISTUREPROOF SHEETS. F. W. Duggan and F. Groff (to Carbide and Carbon Chemicals Corp.). U. S. 2,306,046, Dec. 22. Calendering a continuous vinyl resin film onto a porous fibrous sheet and then applying a very thin coating of hydrocarbon wax.

UREA RESINS. J. E. H. Hayward (to Bakelite Corp.). U. S. 2,306,057, Dec. 22. Blending two urea resins, one made with at least 2 mols and the other with less than 2 mols of formaldehyde to 1 mol of urea.

ESTER POLYMERS. J. G. McNally and R. H. Van Dyke (to Eastman Kodak Co.). U. S. 2,306,071, Dec. 22. Resinous esters derived from monohydric alcohols and heteropolymers of the maleic acid-vinyl alcohol type.

LIGHT POLARIZERS. E. H. Land and H. G. Rogers (to Polaroid Corp.). U. S. 2,306,108, Dec. 22. Orienting the molecules of a transparent plastic by stretching it while hot enough to form light-polarizing dichroic particles from long chain molecules contained in the plastic composition.

STARCH MOLDINGS. P. H. Gugger (to Comolite Corp.). U. S. 2,306,120, Dec. 22. Molding a composition of wood flour, starch and water into shaped articles.

OXALTE POLYMERS. I. E. Muskat (to Pittsburgh Plate Glass Co.). U. S. 2,306,136, Dec. 22. Making infusible, insoluble resins by polymerizing diesters of unsaturated alcohols and oxalic acid.

CROTONATE POLYMERS. M. A. Pollack (to Pittsburgh Plate Glass Co.). U. S. 2,306,139, Dec. 22. Making infusible, insoluble resins by polymerizing crotonates of unsaturated alcohols.

INSULATED WIRE. O. A. Frederickson (to National Electric Products Corp.). U. S. 2,306,159, Dec. 22. Insulating a conductor with asphalt-impregnated fabric sheathed in an elastic film of a plasticized high polymer resin.

TUBING MACHINE. H. C. Harrison (to Bell Telephone Laboratories, Inc.). U. S. 2,306,164, Dec. 22. A device for making extruded tubing has complementary sliding extrusion plates which can be rigidly clamped in concentric position.

MOLDED CAPS. G. J. Crosman, Jr. (to Plastics Inc.). U. S. 2,306,205, Dec. 22. Apparatus for pressing a thermoplastic in a mold to form caps having an internal threaded portion.

LIGNOCELLULOSE MOLDINGS. John G. Meiler. U. S. 2,306,274, Dec. 22. Alkaline digestion of lignocellulose in the presence of an acid-forming substance to make a moldable product.

SAFETY GLASS. M. D. Lardin (to Pittsburgh Plate Glass Co.). U. S. 2,306,314, Dec. 22. Assembling glass plates and a resin interlayer, applying an edge seal and bonding the layers of glass and plastic under heat and pressure.

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PLASTICS ENGINEERING IS YOUR TIME & MONEY-SAVING WAY ON *"CHANGE-OVERS"*

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New Purchasers of Molded Plastics, needing a complete organization, "Take It To Tech-Art"

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PLASTICIZER. W. H. Lycan (to Pittsburgh Plate Glass Co.). U. S. 2,306,315, Dec. 22. Plasticizing polyvinyl acetal resins with a mixed ester of a polyethyleneglycol, an acid not higher than valeric acid and an acid not lower than caproic acid.

INJECTION MOLDING DIE. L. F. Marsh (to Reed-Prentice Corp.). U. S. 2,306,316, Dec. 22. A stationary die and a movable die defining a mold cavity, the stationary die having a sprueway through it.

DIENE INTERPOLYMERS, F. K. Schoenfeld (to B. F. Goodrich Co.). U. S. 2,306,411, Dec. 29. Interpolymerizing a diolefin with an aryl ether type unsaturated compound.

PLASTICIZERS. W. Hentrich, E. Schirm and R. Endres (to Patchem A.-G. zur Beteiligung an Patenten und sonstigen Erfindungsrechten auf chemische Verfahren). U. S. 2,306,440, Dec. 29. As solvents, softeners and plasticizers, trialkyl cyanurates in which at least one alkyl radical is octyl or higher.

CELLULOSE ETHERS. L. Lilienfeld (to Lilienfeld Patents Inc.). U. S. 2,306,451, Dec. 29. Cellulose mixed ethers containing ethyl and alkanol ether radicals are made by successive ethylation and hydroxyalkylation of cellulose.

MODELS FOR TAXIDERMY. Monroe Nowotny. U. S. 2,306,464, Dec. 29. Artificial plastic animal teeth and jaws are made in one-piece upper and lower sections with teeth and tissues forming integral parts of each.

MOISTUREPROOF FOILS. H. S. Holt (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,306,478, Dec. 29. Regenerated cellulose wrapping foils are moistureproofed with wax and a thermoplastic resinous phenol-modified rubber.

ADHESIVE TAPE. J. A. Mitchell (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,306,487, Dec. 29. Adhesive tape which can be removed and used again has a tacky film of chlorinated paraffin wax and phenol-modified rubber.

MULTITONE EFFECTS. J. S. Cummings (to Interchemical Corp.). U. S. 2,306,525, Dec. 29. Imparting multitone effects to blushed lacquer films by applying pressure which varies from one area to another, so that occluded air in the blushed film is expelled in varying degrees.

INSULATED WIRE. O. A. Frederickson (to National Electric Products Corp.). U. S. 2,306,533, Dec. 29. The protective textile jacket of an insulated conductor is sheathed in a high polymer resin, plasticized to a rubber-like consistency.

ACETAL RESIN. K. G. Blaikie and R. N. Crozier (to Shawinigan Chemicals, Ltd.). U. S. 2,306,586, Dec. 29. Using *p-tert.*-amylphenol as inhibitor of discoloration in making vinyl acetal resins.

UREA RESINS. J. E. H. Hayward (to Bakelite Corp.). U. S. 2,306,-697, Dec. 29. Making molding compositions from urea-formaldehyde condensation products and fillers.

STABILIZED RUBBER HYDROCHLORIDE. G. E. Hulse (to U. S. Rubber Co.). U. S. 2,306,731, Dec. 29. Stabilizing rubber hydrochloride against photochemical deterioration by adding a triarylstibine.

MOLDING FIXTURE. T. S. Huxham (to Bell Telephone Laboratories, Inc.). U. S. 2,306,732, Dec. 29. A laminated molding fixture for assembling electrical contact units.

FILM. F. M. Meigs (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,306,790, Dec. 29. Adding a salt of a fatty acid (heptoic acid or higher) to polyvinyl alcohol films as a strip agent.

KNOB. Frank Gits. U. S. 2,306,876, Dec. 29. Molded plastic knobs have a metal shaft-receiving insert bearing a boss, both insert and boss being tapped to receive a set screw.

PROTECTIVE PASTE. Rudolf Klose (vested in the Alien Property Custodian). U. S. 2,306,887, Dec. 29. A covering paste which can be applied to an article and later peeled off is made of methylcellulose, paraffin oil, glycerol and water.

AMINE RESINS. J. M. and R. P. Weiss (to Research Corp.). U. S. 2,306,918-9-20, Dec. 29. Making resins by condensing maleic anhydride or the like with a primary, secondary or tertiary aliphatic amine.

INFUSIBLE RESINS. W. Zerweck, M. Schubert and E. Heinrich (to General Aniline and Film Corp.). U. S. 2,306,924, Dec. 29. A hard, opaque, infusible acidproof and alkaliproof resin is made by condensing formaldehyde with furfuryl alcohol.

PLASTICIZERS. D. D. Lanning; T. R. Latour (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,306,963; 2,306,964, Dec. 29. Adding 0.5 to 5 percent of dilauryl phosphate to dry-casting solutions of ethyl cellulose; and plasticizing cellulose derivative films with 0.5 to 5 percent of benzyltrimethylammonium laurate.

MOLDING MACHINE. W. E. Lindstrom and G. v. B. King (to Lindstrom and King). U. S. 2,306,965, Dec. 29. An extrusion press for shaping stiff plastic materials from preliminary mold cavities.

PLASTICIZERS. W. Gumlich and E. Konrad (to Jasco Inc.). U. S. 2,307,037, Jan. 5. Plasticizing rubber-like interpolymers of the butadiene-styrene and butadiene-acrylonitrile types by adding a drying oil acid and not over 4 percent of an antioxidant, then subjecting the product to oxidizing.

STRETCHING FILMS. Henry D. Minich. U. S. 2,307,056, Jan. 5. Thermostretchable films are stretched while hot, allowed to retract as much as they will and then wound on rolls.

MOISTUREPROOF FILM. J. A. Mitchell (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,307,057, Jan. 5. Moistureproofing transparent films with wax, plasticized chlorinated rubber and transparentized halogenated paraffin wax.

VINYL RESIN. W. M. Quattlebaum and D. M. Young (to Carbide and Carbon Chemicals Corp.). U. S. 2,307,075, Jan. 5 Preventing thermal discoloration of vinyl resins by adding a small amount of a metal chelate derivative of a 1,3-diketone or the like.

FILM. J. E. Snyder (to Wingfoot Corp.). U. S. 2,307,081, Jan. 5. Casting rubber hydrochloride film from a cement containing more wax than is compatible with the rubber hydrochloride.

STABILIZED VINYL RESINS. V. Yngve (to Carbide and Carbon Chemicals Corp.). U. S. 2,307,090-1-2, Jan. 5. Stabilizing vinyl resins such as polyvinyl chloride or "Vinylite" type resins by adding an aliphatic lead carboxylate; plasticizing "Vinylite" type resins with retene; and stabilizing vinyl resins with a tin carboxylate.

THREADED PLASTICS. Jakob Dichter (vested in the Alien Property Custodian). U. S. 2,307,114, Jan. 5. Apparatus for threading the open ends of plastic shapes with a hot die, actuated by a rubber-tipped plunger.

STABILIZER. W. M. Quattlebaum, Jr., and C. A. Noffsinger (to Carbide and Carbon Chemicals Corp.). U. S. 2,307,157, Jan. 5. Stabilizing vinyl chloride type resins by incorporating with them tin maleate or an analogous tin salt.

STIFFENED FABRIC. W. Whitehead (to Celanese Corp. of America). U. S. 2,307,178-9, Jan. 5. Fabrics with horsehair weft and with the warp formed partly of thermoplastic yarn are stiffened by treatment with a plasticizer for the thermoplastic.

PHONOGRAPH RECORDS. V. Yngve (to Carbide and Carbon Chemicals Corp.). U. S. 2,307,180, Jan. 5. A powdered cellulosic or ligno-cellulosic filler is used, along with a moderately hard finely powdered abrasive, in phonograph records made of "Vinylite" type resins.

COATED FABRIC. R. L. Lester (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,307,225, Jan. 5. Applying to fabrics a thin film of a thermoplastic cellulose ether and then a thin film of a thermosetting urea resin.

CAPACITOR. F. M. Clark (to General Electric Co.). U. S. 2,307,488, Jan. 5. Cellulose acetate films, not over 0.3 mil thick, are coated with liquid chlorinated diphenyl for use in electric capacitors.

INSULATED WIRE. E. H. Jackson and R. W. Hall (to General Electric Co.). U. S. 2,307,588, Jan. 5. Hard, flexible, tough, abrasion-resisting insulating films for electric conductors are formed from a thermosetting phenol-aldehyde modified vinyl acetal resin.

ROSIN POLYMERS. A. L. Rummelsburg (to Hercules Powder Co.). U. S. 2,307,641, Jan. 5. Polymerizing rosin or its esters in a volatile organic solvent with the aid of ethylsulfuric acid or the like.

ACROLEIN RESINS. K. M. Herstein (to Acrolein Corp.). U. S. 2,307,742, Jan. 12. Making resins by acid condensation of urea with acrolein.

DRY CELL ENVELOPES. Cyril P. Deibel. U. S. 2,307,761-2-3-4-5-6-7-8-9-70, Jan. 12. Battery units comprising several dry cells arranged in a single casing have the individual cells enveloped in a thin layer of insulating material such as "Pliofilm," with means for connecting adjacent cells in series.

COATING METALS. C. J. Malm and G. J. Clarke (to Eastman Kodak Co.). U. S. 2,307,783, Jan. 12. Coating metals with a strongly adherent, moderately heat-resistant film of cellulose acetate butyrate or acetate caproate.

BOND FOR RUBBER. R. C. Pierce (to National Standard Co.). U. S. 2,307,801, Jan. 12. Bonding rubber to copper-coated metal by means of a resin which is compatible with rubber.

TUBING. P. R. Austin (to E. I. du Pont de Nemours and Co., Inc.) U. S. 2,307,817, Jan. 12. Tubing made of a synthetic linear polyamide is stretched to increase its wet bursting strength.

PLUGGING FORMATIONS. C. H. Mathis and C. Rampacek (to Phillips Petroleum Co.). U. S. 2,307,843, Jan. 12. Introducing a liquid urea-furfural resin composition into oil well formations and completing resinification therein.

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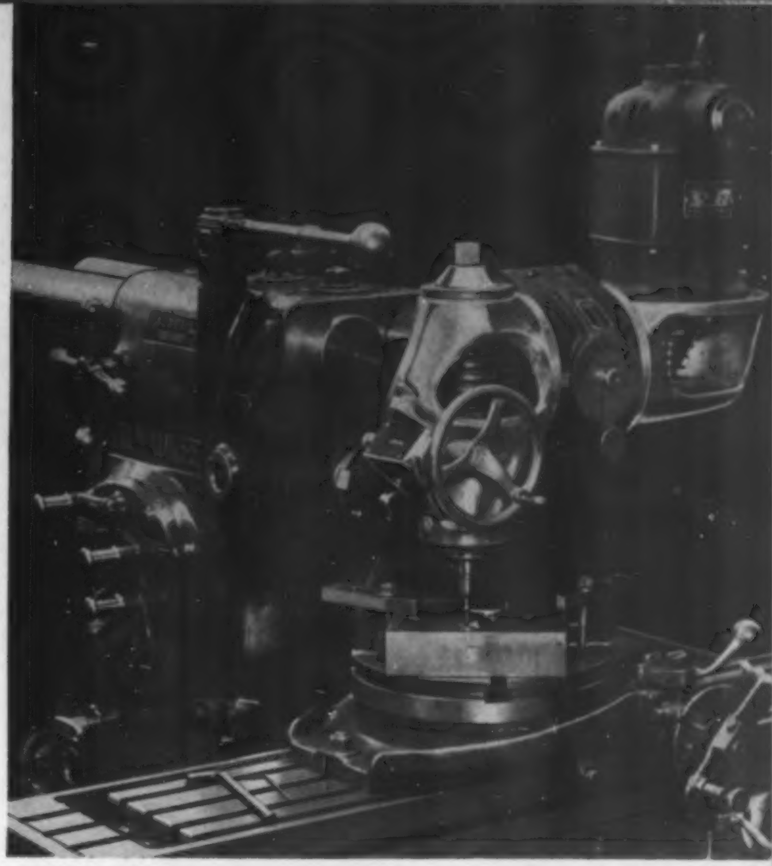

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COATING METALS. C. L. Shapiro (to Atlas Powder Co.). U. S. 2,307,861, Jan. 12. Coating metals with a baked "Vinylite" type resin film over a baked asphaltic primer.

PETROLEUM RESINS. R. L. Betts (to Standard Oil Development Co.). U. S. 2,307,873, Jan. 12. A solvent extraction method of separating pale petroleum resins, with softening points between 100° and 200° F., from darker petroleum resins with higher softening points.

GLAZED CHINTZ. H. Corteen (to Tootal Broadhurst Lee Co., Ltd.). U. S. 2,307,876, Jan. 12. Coating chintz fabrics first with an acrylate ester resin and then with a plasticized blend of an alkyd resin and a urea-formaldehyde resin.

LAMINATED SHEETING. P. C. Seel (to Eastman Kodak Co.). U. S. 2,307,962, Jan. 12. Joining chlorinated rubber films to cellulose ester films by an interlayer of a vinyl resin which is sensitive to heat and pressure.

THERMOPLASTIC SHEETING. M. L. Piker (to Eastman Kodak Co.). U. S. 2,308,024, Jan. 12. Forming continuous sheets of a cellulose derivative while imparting a roughened surface to the sheet by solvent evaporation in a humid atmosphere.

CUTTING PLASTICS. H. M. Dodge and W. K. Daniells (to Libbey-Owens-Ford Glass Co.). U. S. 2,308,061, Jan. 12. Apparatus for feeding ribbons of plastic sheeting, arranged in loose horizontal folds, to a cutting machine.

MELAMINE RESINS. W. Fisch (to Ciba Products Corp.). U. S. 2,308,069, Jan. 12. Making melamine-aldehyde resins by heating a liquid ammonia solution of a cyano compound and heating the product with an aldehyde.

HEEL. Henry N. Pearson, Henry J. Wiedemeyer and Wm. J. Walsh (to L. E. Sauer). U. S. 2,308,103, Jan. 12. Molding plastic heels with more nail holes than the required number of nails.

ACETATE FILMS. F. P. Alles (to E. I. du Pont de Nemours and Co., Inc.) U. S. 2,308,141, Jan. 12. Making cellulose acetate films by extrusion into a coagulating bath containing a water-soluble amine.

INFUSIBLE POLYMERS. M. A. Pollack, I. E. Muskat and F. Strain (to Pittsburgh Plate Glass Co.). U. S. 2,308,236, Jan. 12. Two-stage polymerization of esters derived from a polyhydric alcohol and at least two molecules of an unsaturated monocarboxylic acid.

DISSOLVING PLASTICS. R. R. Dreisbach (to Dow Chemical Co.). U. S. 2,308,416, Jan. 12. Dissolving thermoplastic resins in a down-flowing solvent while passing an inert vapor upward around the resin.

FLOCK FINISH. R. G. Smith and W. J. Physioc, Jr. (to Atlas Powder Co.). U. S. 2,308,429, Jan. 12. Improving the wearing and soilproof qualities of flock-finished fabrics by applying an enamel containing ethylcellulose, cellulose acetate and a "Vinylite" type resin.

PLYWOOD. J. A. Potchen and Olin H. Basquin (to John F. Neary, Jr.) U. S. 2,308,453, Jan. 12. Apparatus for shaping plywood with a thin metal die under fluid pressure.

RESIN DISPERSIONS. H. C. Cheetham and R. J. Myers (to Resinous Products and Chemical Co.). U. S. 2,308,474, Jan. 12. Forming an oil-in-water emulsion of a drying oil modified alkyd resin, casein and a water-soluble cellulose ether.

SURGICAL CASTS. Roger Anderson. U. S. 2,308,483, Jan. 19. Forming casts or splints from coils of a plastic composition, interconnected in strips.

POLYMERS. G. F. D'Alelio (to General Electric Co.). U. S. 2,308,-494-5, Jan. 19. Polymerizable compositions in which an unsaturated alkyd resin is blended with a polycrotyl ester of a polycarboxylic acid, or with an allyl ester of an acid having only one esterifiable group.

ALKYDS. K. A. Earhart and B. Rabin (to Devoe and Raynolds Co., Inc.). U. S. 2,308,498, Jan. 19. Forming composite esters from drying oil modified alkyd resins by heating with a high-boiling solvent.

TERPENE RESIN. Israel Rosenblum. U. S. 2,308,544, Jan. 19. Making fusible, soluble terpene-modified phenol-formaldehyde resins by effecting resinification in presence of dipentene, terpineol or pine oil.

METHACRYLATES. C. E. Barnes (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,308,581, Jan. 19. Forming a hard interpolymer of methacrylic anhydride and methy methacrylate.

PREHEATING PLASTICS. Knut E. B. Stenberg. U. S. 2,308,632, Jan. 19. Powdered thermosetting molding compositions are preheated by tumbling the powder in two directions in an inclined heat-jacketed cylinder.

INJECTION MOLDING. W. R. Wheeler (to Carbide and Carbon Chemicals Corp.). U. S. 2,308,636, Jan. 19. Injection molding heat-sensitive vinyl resins in apparatus adapted for efficient heat conduction so that overheating is avoided.

POLYAMIDE COATINGS. J. H. Balthis and A. W. Larchar (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,308,638, Jan. 19. Applying even, bubble-free coatings of a synthetic linear polyamide from a melt to a moving central core of wire or the like.

RECORD BLANK. C. F. Cummins and J. L. Sherk (to Dow Chemical Co.). U. S. 2,308,676, Jan. 19. Blanks for recording sound by lateral embossing are made of ethylcellulose with not over 25 percent of a hydrogenated fat.

SEMICARBAZIDE RESIN. F. L. Johnston (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,308,696, Jan. 19. Water-insoluble resins, derived solely from aliphatic compounds, are obtained by condensing semicarbazide with formaldehyde.

ABRASIVES. C. E. Barnes (to Norton Co.). U. S. 2,308,853-4, Jan. 19. Bonding abrasive grains with a copolymer of an alkyl acrylate, chloroacrylate or methacrylate and a vinyl or isopropenyl ester of one of the same acids, or with one of the anhydrides of these acids.

INSULATED WIRE. Johannes Hoekstra and Joseph E. H. Rieter (vested in the Alien Property Custodian). U. S. 2,308,975, Jan. 19. Coating wire with plasticized chlorinated rubber and then with a cellulose ester or ether.

SHOE STIFFENER. A. P. Swett (to Beckwith Mfg. Co.). U. S. 2,309,023, Jan. 19. Impregnating fabric with a coumarone-indene resin compounded with rubber, wax and rosin.

PLANOGRAPHIC PLATES. Wm. C. Toland and Ellis Bassist (to Wm. C. Toland). U. S. 2,309,027, Jan. 19. Planographic printing plates have a vinyl surface layer to which the photosensitized coating is applied.

TREATING PAPER. J. V. Bauer and D. N. Hawley (to Stein, Hall Mfg. Co.). U. S. 2,309,089-90, Jan. 26. Improving the wet strength of paper by forming a urea-aldehyde resin on the fiber.

PARACHUTE. G. E. Giroux (to Aerial Products, Inc.). U. S. 2,309-, 107, Jan. 26. Forming parachutes of thermoplastic sheeting with thickened edges and a relatively thin domed portion.

ABRASIVE BLOCKS. L. A. Hatch (to Minnesota Mining and Mfg. Co.). U. S. 2,309,108, Jan. 26. Encasing abrasive grains in a synthetic resin, mixing them with a solution of rubber and a synthetic resin and shaping the product into waterproof flexible blocks.

PELLETS FOR MOLDING. H. M. Dent, S. H. Hall and L. A. Sontag (to Durez Plastics and Chemicals, Inc.). U. S. 2,309,342, Jan. 26. Making a paste of a liquid thermosetting resin and a filler, forming the mix into pellets, then drying and tumbling the pellets.

VINYLIDENE RESINS. J. L. Williams (to Dow Chemical Co.). U. S. 2,309,370, Jan. 26. Increasing the tensile strength of vinylidene chloride polymers by an aging heat treatment of the stretched resin.

CASEIN PLASTICS. G. H. Brother and L. L. McKinney (to the Secretary of Agriculture of the U. S. A.). U. S. 2,309,380, Jan. 26. A thermoplastic molding powder made of hardened casein plasticized with ethyleneglycol.

INJECTION MOLDING. E. S. Bird, L. F. Marsh and G. Smith (to Reed-Prentice Corp.). U. S. 2,309,496, Jan. 26. A heating device for injection molding machines has a main channel and several smaller ones branching from it, each being heat-jacketed.

MOLDING COMPOSITIONS. B. M. Marks (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,309,522, Jan. 26. Preparing colored granular molding compositions with high bulk density from a methyl methacrylate resin and a dye solution.

WATER-SOLUBLE RESIN. H. Burrell (to Ellis-Foster Co.). U. S. 2,309,610, Jan. 26. A resin made by alkaline condensation of phenol with formaldehyde is used in waterproofing sizes and binders for textiles or the like, in which it is rendered insoluble and infusible.

SULPHURIZED PLASTIC. M. B. Chittick and P. V. McKinney (to Pure Oil Co.). U. S. 2,309,692, Feb. 2. Making a solid plastic by heating polymerized petroleum gum formers with sulfur.

MOLDING POLYMERS. W. E. Gordon (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,309,729, Feb. 2. Obtaining tough rigid shapes by injection molding of synthetic linear polymer melts.

TRIAZINE RESIN. G. Widmer and W. Fisch (to Ciba Products Corp.). U. S. 2,310,004, Feb. 2. Molding compositions containing products formed by condensing aminotriazines with formaldehyde.

NITROLIGNIN PLASTIC. H. Burrell (to Ellis-Foster Co.). U. S. 2,310,010, Feb. 2. A nitrolignin-aldehyde reaction product is used as binder in molding compositions.

BATTERY SEPARATORS. M. T. Harvey (to Harvel Corp.). U. S. 2,310,077, Feb. 2. Using polymerized cashew nut shell liquid for nonconducting separator sheets.

PUBLICATIONS

Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent postpaid at the publishers' advertised prices

Chemistry of Engineering Materials, 4th Edition

by R. B. Leighou and J. C. Warner

McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, 1942

Price $4.50 **645 pages**

The selection and use of metallic and non-metallic materials in building construction and equipment and machinery construction and operation are discussed in this book, which has been revised by seven members of the chemistry faculty of the Carnegie Institute of Technology. In general, emphasis has been placed upon the properties of engineering materials rather than upon processes for their manufacture. The organic materials are covered in chapters on plastics, natural and synthetic rubber, protective coatings, glues and adhesives, thermal and electrical insulators and fuels and lubricants. G.M.K.

War Gases

by Morris B. Jacobs

Interscience Publishers, Inc., 215 Fourth Ave., New York, 1942

Price $3.00 **180 pages**

The physical characteristics, physiological response and effects on various materials, foods and water of war gases are reviewed. Methods of identification and decontamination are described. A great deal of the information is presented in tabular form convenient for quick reference. G.M.K.

Science Remakes Our World

by James Stokley

Ives Washburn, 27 West 57th St., New York City, 1942

Price $3.50 **298 pages, illustrated**

New products, new industries, new jobs—the industrial revolution into which the discoveries of science have catapulted the lives of Americans is presented in a fascinating story of the evolution of many modern day actualities. The book is written in simple, non-technical language, and should be of interest to layman and scientist alike. An idea of its diversified subjects may be gathered from the chapter titles which include: "Explosives in Peace and War," "The Realm of Plastics," "Rubber from Tree and Test Tube," "New Metals," "Mining the Ocean," "The Age of Electrons," "Radio Today and Tomorrow," "New Sounds in the Theatre" and others. The book projects itself into the future, concluding with a chapter on "New Sources of Power." E. D.

★ THE FIRST ISSUE OF "THE ROHM & HAAS REPORTER" makes its bow with the February issue, published by Rohm & Haas Co., Washington Sq., Philadelphia, Penna. Its purpose is to familiarize users of chemicals with the company's products. Keeping abreast of the news, it gives the history of a number of their materials from origin to present day uses, which are well illustrated by photographs.

★ A 4-PAGE REFERENCE BULLETIN BY HARDINGE BROTHERS, Inc., Elmira, N. Y., contains specifications for the use of precision collets and feed fingers with Brown & Sharpe machines. A single leaflet describes their Master Feed fingers and standard pads.

★ "CHROMIUM PROTECTION" IS THE TITLE OF AN ATTRACTIVE booklet prepared by Chromium Corp. of America, 120 Broadway, New York City, which is designed to give helpful information on the subject of industrial chromium plating. A complete description of the characteristics of their product, Crodon, and the facilities and services offered by their company are supplemented by illustrations showing typical applications.

★ A BOOKLET ON THE SUITABILITY OF VARIOUS THERMOplastics for nameplates is available from the Cruver Mfg. Co., 2456 W. Jackson Blvd., Chicago, Ill. Specifications of the formulations and essential high spot information is included in concise form.

★ THE BRITISH PLASTICS FEDERATION LIMITED, 47–48 PICcadilly, London, W. 1, has issued its chairman's report to the annual general meeting held February 16, covering briefly the activities of the Federation during the past year. It gives the highlights of their cooperation with Government, Service departments and numerous organizations in increasing production and upon the research and development work which has been accomplished.

★ "WAR PRODUCTION IN 1942," ISSUED BY THE DIVISION OF Information, WPB, Washington, D. C., is a report on the progress of production in our first year of war. Following an exposition on the stages of production step-up, the major problems of materials, conversion of industry and program adjustments are reported upon in detail, together with a listing of organizational developments.

★ MANUAL ON ASSEMBLY GLUING, ISSUED BY THE SOCIETY of the Plastics Industry, Inc., 285 Madison Ave., New York City, is intended primarily as a ready reference for shop use. The technique of gluing, the characteristics of the resins and all such information as is pertinent to promoting cold assembly gluing involving structural loads are included in this booklet which was prepared by the Resin Adhesive Division of the Society. Price $1.00.

★ A STUDY ON STAINS AND VARNISHES IS COMPREHENSIVELY covered in Bulletin No. 668 of the Calco Chemical Div., American Cyanamid Co., Bound Brook, N. J. Entitled, "The Formulation and Uses of Stains," and written primarily for the paint and varnish trade by William H. Peacock, the booklet offers much of interest to all users of dyestuffs.

★ "DESIGNING MOLDED PLASTIC PARTS" IS AN ENLARGED edition of a similar booklet previously issued by the General Electric Co.'s Plastics Dept., Pittsfield, Mass. It is intended for product engineers and includes technical material on inserts, shrinkage, tolerances, wall thickness, holes, undercuts, ribs, bosses, fillets, threads, assembly devices, materials and properties.

★ CATALOG NO. 42 OF THE CONSTRUCTION MACHINERY CO., Waterloo, Iowa, contains complete information on the construction equipment of this company—pumps, mixers, batching and placing equipment, hoists and power saw rigs. Shown with the descriptions and specifications of the equipment are illustrations of the individual pieces and many photographs of the items in work.

★ AN 8-PAGE ILLUSTRATED FOLDER PREPARED BY MARKEM Machine Co., Keene, N. H., fully describes their variable designation machines and the services they perform in marking objects of every shape and type of material either by imprint or indenting in one or two colors. The folder gives an informative insight on advanced marking methods.

★ "ATLAS SPANS AND ATLAS TWEENS," SURFACE ACTIVE agents, are described in a technical booklet published by Atlas Powder Co., Wilmington, Delaware. The book contains formulas, specifications and solubilities of the materials as well as tables on surface activity, interfacial tension and spreading coefficients.

★ THE LATEST ISSUE OF "EQUIPMENT NEWS," PUBLISHED BY Farrel-Birmingham Co., Inc., Ansonia, Conn., describes the available facilities and equipment of their pilot plant. Also described are recent developments in their machinery, including Banbury mixers, mills, Gordon plasticators, calenders and molding presses.

★ "THE ASBESTOS FACTBOOK," RECENTLY PUBLISHED BY *Asbestos*, Philadelphia, Pa., contains a compact assemblage of asbestos facts, including a short history of its origin and a sizable list of its more important uses. Handy for speakers, teachers and members of the industry as a source of general information.

★ THE SEVENTH REVISED EDITION OF THE CLASSIFIED DIrectory of the Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41st St., New York City, gives a preliminary introduction to services offered by the Association which, in the interests of chemistry, acts as a clearing house for consultants. The current directory includes a membership list arranged alphabetically by name and by company, statements of the functions and activities of the organizations, records of the work handled by the members and a conveniently keyed index. Copies may be obtained from the Association without charge.

(*Please turn to page 158*)

Washington Round-Up

Current news, Government orders and regulations affecting the plastics industry, with analyses of the plastics situation

CONTROLLED MATERIALS PLAN

Just what the plastics industry is going to have to do under recent revisions of the Controlled Materials Plan is a little vague as yet, but we can report at this time that manufacturers of plastics and synthetic resins, including molders and fabricators, may get AA-1 priority ratings for obtaining maintenance, repair and operating supplies under the Controlled Materials Plan Regulation No. 5.

Definitions under the order call maintenance "the minimum upkeep necessary to keep a facility in sound working condition," and repair is defined as "the restoration of a facility to sound working condition when the same has been rendered unsafe or unfit for service by wear and tear, damage, failure of parts and the like." "Operating supplies" include "any material or products which are normally carried by a person as operating supplies according to established accounting practice and are not included in his finished product . . ." This definition was interpreted at WPB to include such supplies as steel for molds, etc.

The same regulation puts maintenance, repair and operating supplies for manufacturers of plastics working machinery in the AA-1 rating category, along with the manufacturers of many products in various essential end use classifications which are partially or wholly made of plastics. Among these are most electrical products, virtually all direct-military products such as ammunition, combat vehicles, tanks, ordnance, engines and parts, and communication equipment.

Also specifically eligible for the AA-1 rating are manufacturers of molded plastic closures, rubber and rubber products (natural and synthetic) and many other essential plastic products. Although the original order did not definitely define molders and laminators as "manufacturers of plastics and synthetic resins," an interpretation from WPB includes them.

At the same time it is learned that a new list is now being drawn up to include molders and laminators, by terms understood by the industry, in the AA-1 group.

However, here's another angle: there's a new order in the works (it probably won't be out until after you've read this), which will designate those molders and those molding jobs (and this applies to all other fabricators, laminators, etc., of plastics) which are eligible to receive high ratings for maintenance, repair and operating supplies. So, for the next month or so, the equipment and supplies necessary for maintenance, repair and operation will be on the AA-1 list for all molding and fabricating jobs. But when the projected order (it may be called P-89) comes out, it will restrict priorities to essential end uses, and makers of civilian gadgets will be relegated to A-10 ratings or lower, known as "hunting licenses."

ABOUT "INTERIM ASSISTANCE"

Molders and other users of phenolic resins have been requested by WPB's Plastics Branch to cut down their requests for "interim assistance" in the procurement of supplies to an irreduceable minimum. Under order M-246, providing for allocation of phenolic resins, all users are required to submit applications for monthly requirements on or before the 18th of the month preceding the month in which materials are to be delivered. There are certain provisions for interim assistance in cases where users miscalculate or underestimate their requirements.

During the early days of the order, the need for interims was recognized, as the industry was getting itself adjusted to the new allocation order; but now, the Branch feels, these requests could be reduced still further—to the point where they will not be used except in cases where a shortage of material actually threatens a shutdown of production on vital and essential products for the war effort. Better planning of production for months ahead would go a long way in curtailment of the "interims," it was said. Aside from this one phase, administration of the allocation order is operating smoothly.

A COUPLE OF THINGS ABOUT SHELLAC

WPB's Chemical Division announces it will make an effort to make available at least a limited supply of shellac for use in production of aniline inks when no satisfactory substitute can be found. Printing ink manufacturers were told to file form PD-617, for one month's requirements at a time.

Rumors that certain makers of phonograph records have been given authority to use 15 percent of their shellac inventory in the making of current records was discounted by WPB attaches. They said that the Army and Navy were getting shellac for all their needs, and that a small amount is being left over, month by month, for civilian needs (and the morale value of some types of phonograph records is not being discounted). However, no order has gone out authorizing anyone to use 15 percent of his current stockpile of shellac (at this writing) and probably none will.

WPB SHAKEUP

As this is written, it appears that the civilian economy of the nation has gained a victory of some sort over the military. Donald Nelson, Chairman of WPB, has dismissed Ferdinand E. Eberstadt, program vice-chairman, who is known to be the friend of the military at WPB. Charles E. Wilson has taken over Mr. Eberstadt's duties, with the title of executive vice-chairman.

In announcing the change, Nelson declared that the big problem now is production rather than flow of materials, and that control of materials, while still important, is transcended by production problems.

CLEARING OFFICE SET UP

Harrassed businessmen who come to Washington "cold," seeking an answer to their war production problems, now may be enabled to save a little of the time and worry previously attendant upon their Washington visits. A new unit, set up within WPB, will answer their questions and refer them to the proper WPB or other War Agency officials. Designed to eliminate, or at least minimize, confusion and delays on the part of businessmen who want information about where to take their problems, the new organization will be staffed by specialists and equipped to answer queries by telephone or in person. It will operate as a subdivision of the Business Services branch of the Administrative Division, WPB.

CMP REGULATION NO. 3

CMP Regulation No. 3, augmenting No. 5, discussed above, defines the place of preference ratings under CMP. By the terms of Regulation No. 3 preference ratings will be assigned to deliveries of all materials necessary to complete an authorized production schedule for which allotments of any of the three controlled materials—aluminum, copper and steel—are made to a prime contractor manufacturing Class A or B products.

When an allotment is passed on to a secondary consumer manufacturing Class A products, the prime consumer making the allotment applies to the secondary's authorized production schedule the same rating he has received for his own related schedule, for use with the appropriate allotment number or symbol. A delivery order bearing a preference rating and an allotment number or symbol outranks an order bearing the same rating but no allotment identification. It is not, however, superior to another order bearing a higher rating. For example, a rating of AA-2X with an allotment number takes precedence over another AA-2X rating without an allotment number, but is secondary to a rating of AA-1 with or without an allotment number.

Any authorized controlled material order as defined in CMP Regulation No. 1, rated AAA, placed with a warehouse or another who is not a controlled material producer, takes precedence over all other orders. However, authorized controlled material orders placed with a producer of controlled materials must be accepted and filled as provided in CMP Regulation No. 1, without regard to ratings and in preference to all other orders. To the extent that producers are able to fill other orders, prior to July 1, 1943, they must do so in accordance with the preference ratings assigned or extended. After July 1, 1943, no controlled materials may be delivered except on orders bearing allotment numbers.

A prime consumer who manufactures Class B products and has received an authorized schedule, accompanied by a preference rating to be used with his allotment number, may not extend any other rating received from a customer, except an emergency rating of AAA. This rating may be extended in such cases only to obtain production material required to fill the order to

which it is applicable and not for the purpose of replenishing inventory. Use of the allotment symbols MRO and SO (small order) in connection with preference ratings is also provided for in Regulation No. 3.

The new regulation prescribes a form of certification which must be filed by a prime or secondary consumer when placing an allotment number or symbol on a rated delivery order. A prime secondary consumer who receives a preference rating for an authorized production schedule may use the rating with the appropriate allotment number or symbol only to obtain production materials in the minimum practicable amounts required to complete the schedule, or to replace production materials in his inventory.

NITROCELLULOSE END USE MUST BE SPECIFIED

Under an amended version of General Preference Order M-196, covering allocation of soluble nitrocellulose, suppliers of the product, either new or scrap, must indicate on their application for nitrocellulose the quantity required for each individual customer for each primary product, and the product or end-use applying to each individual order. Thus, the order goes on down the line to purchasers of the products, who must accompany their orders with specific descriptions of the use to which they want to put the nitrocellulose. And by specific, WPB means just that, listing as an unsatisfactory example the simple description "furniture," as end product use. Instead, the certificate which must be filed with the supplier must show whether the product is to be used on the furniture as a sealer, finish coat or other type of application, as well as showing what type of furniture it is to be used on, and where it will be used; for example, home, office, Army, etc. The certificate provides also that each purchase order certify that the material covered is to be used only for the specific purposes listed on the order.

The amended 196 also brings washed film scrap and other nitrocellulose scrap under the allocation provision. Heretofore dissolved film scrap was specifically included in the term "soluble nitrocellulose," but undissolved film scrap was not. As a result, washers of film scrap found that in filling purchase orders their product was subject to allocation when dissolved, but if it had not been dissolved, allocation did not apply.

Allocation under the amended order applies to prime nitrocellulose in the dehydrated, alcohol wet, xylol wet or water wet condition. It covers all scrap, including smokeless powder scrap (regardless of nitrogen content), washed film scrap and all other soluble nitrocellulose scrap, including plasticized soluble nitrocellulose scrap. It does not include any base solution, unwashed film scrap, still film, or nitrocellulose suitable for dynamite manufacture.

The amended order eliminates a provision allowing without specific allocation by the Director General the delivery of nitrocellulose under certain condition to anyone ordering less than 1000 lb. in each month. The revision requires specific allocation for all amounts in excess of 232 lb. per month. This applies not only to acceptance, but also to use.

PLASTICS ON SHORTAGE LISTS

The seventh issue of the Material Substitutions and Supply list of WPB lists a number of plastics materials in Group I, which are the materials available, supplies of which are "insufficient for war demands and essential civilian demands; and, in many cases, for war demands alone. Materials listed in this category include copolymers of vinyl acetate and vinyl chloride, ethyl cellulose, methyl methacrylate, phenolic laminates, including rods, tubes and molding compound; polystyrene, polyvinyl acetate, birch and Douglas plywood and vulcanized fiber. Methyl methacrylate is starred on the list as being among the most critical of all.

Commenting on the shortage of these plastics, a WPB official said:

"We are short of benzol and derivatives. Change benzol into phenol, and phenol into picric acid, and you have one of the high explosives used to propel heavy calibre naval shells. So if your neighborhood paint store no longer stocks solvent paint remover, remember it may be a part of the explosive behind the shell about to send another Jap warship to the bottom.

"Nor do we have enough methyl methacrylate, the new transparent plastic used until recently for the handles and frames of ultra-modern handmirrors and handbrushes. Methyl methacrylate now is permitted in the manufacture of only two products: dentures and transparent bomber noses. Methyl methacrylate is preferred to glass in its war application, because glass shatters upon impact, while a bullet usually makes little more than a small hole and limited fractures in the methyl methacrylate.

In Group II are listed still other plastics. Materials listed in this group are "essential to the war program," but present supplies are sufficient to meet war demands and essential civilian demands. In this group are listed cellulose, including acetate, acetate butyrate and nitrate, melamine molding compound, urea formaldehyde molding compound and vinylidene chloride.

The only plastics listed in Group II, "materials that are available in quantities significant enough to make them available as substitutes for scarcer materials," are bitumen, casein and lignin.

"American resourcefulness in using the non-critical Group III materials as substitutes for the materials in Groups I and II will continue to play an important part in winning the war," the WPB spokesman said.

NOREPOL IN COMMERCIAL PRODUCTION

Two companies are now making Norepol, the rubber substitute from vegetable oils announced six months ago by the Department of Agriculture as having been developed in the Northern Regional Research Laboratory, Peoria, Ill., in commercial production, the Department of Agriculture announces. However, the year's tonnage of the product (whose name comes from *NO*rthern *RE*search *POL*ymer) will not be great, when compared to the nation's rubber demands.

Laboratory tests and tests in commercial plants show possibilities for many uses for Norepol, according to Agriculture Department spokesmen, including molded and extruded applications, such as rubber heels, fruit jar rings, tubing and gasket material. At least one manufacturer of glass containers for preservation of fruits and vegetables—both for commercial and home-canning purposes—is known to be working on experiments designed to develop Norepol sealing rings.

PLASTICS MACHINERY ALLOCATED

Manufacture and distribution of all plastics molding machinery has been sharply curtailed in a sweeping revision of L-159 by the WPB. Under the amended order, the only machines on which delivery is allowed without special WPB authorization are those which were not only allowed under the old order but were also completely manufactured and assembled prior to January 29. Application for this special authorization must be made on form PD-741.

In addition to this restriction, the WPB clamped down on maintenance and repair parts by providing that deliveries of them can be made only in case of actual breakdown if the needed part is not in inventory, or if it is necessary to replace a part drawn from inventory in order to keep such inventory at a practicable working minimum. It was made quite clear in the order that no new machinery will be allocated under the PD-741 application unless it is needed for war work which cannot be performed by existing equipment, even though this equipment may not be in the hands of the particular contractor who is applying for new equipment.

Included under the restrictions of the order were: injection, compression, laminating, tube and rod molding presses and tube rolling machines. All types of presses—hydraulic, automatic and mechanical—were covered. WPB officials intimated also that a further forcing of the industry—especially the thermoplastic molders—into war production will probably come soon through special regulations governing the distribution of mold steel.

WPB WORKING ON PHENOL SUPPLY

Lack of availability of phenol or one of the phenolic materials has made it difficult for the thermosetting plastic processors industry to maintain production, members of the Advisory Committee for that industry told WPB officials at a recent meeting. This difficulty has been accentuated by the fact that the majority of the available phenol has been placed in the resin producers' hands during the latter part of each month, rather than distributed uniformly throughout the month for which allocation was made. To solve this problem, members urged that the Chemicals Division of WPB expedite the building of new phenol producing facilities already under way.

Some of the manufacturers of materials made with resins based on cresol and cresylic acid reported progress in substituting phenol for a portion of their production that previously involved these critical materials. Laminated materials that meet the requirements of Navy Spec. 17-P-5 have been produced and plans for further substitution are to be followed as vigorously as possible. This effort is necessary owing to the fact that there are other growing important war uses of cresol and no prospect for increased production of this material.

Members of the committee pointed out also that in certain processes a portion of the phenolic material employed deteriorates over a period of time to the point where it is no longer satisfactory for its original use. It was agreed that, rather than waste the material involved in this instance, arrangements should be made to allocate such material for less critical uses and it was suggested each case be considered separately by WPB upon the presentation by the owner of all the pertinent facts including a description of the new intended use of such sub-standard material.

DEFINITIONS OF ESSENTIALITY

Declaring that a "war job" is not necessarily a job in aircraft or ships, ordnance, or ammunition, WMC chief McNutt clarified his "work or fight" declaration with a later statement which asserted that "people must be


WHAT PART
WILL PLASTICS
PLAY IN THE
WORLD OF
TOMORROW
?

housed and clothed and fed in wartime as well as in peace; essential civilian activities are on an equal plane with basic war activities in our war effort." Among the activities which he declared essential, and which are of interest to the plastics industry, in whole or in part, are:

Production of aircraft and parts, production of ships, boats and parts; production of ammunition; production of chemicals and allied products, and essential derivatives thereof; production of communication equipment, and a number of others.

SOFTWOOD PLYWOOD

The supply of softwood plywood has become so critically limited that the possibilities of total allocation should be carefully studied by the War Production Board, according to a recommendation by the Softwood Plywood Industry Advisory Committee. The committee further reported that production is decreasing and will not meet increased demands. Committee members studied the possibilities of further simplification of production methods and substitution of other species of woods for Douglas fir in an effort to increase the output. It was suggested that the possibilities of using Noble fir be thoroughly explored and that logs of this species, not required for aircraft lumber, be made available to plywood mills willing to use them.

The mills reported the labor situation satisfactory in so far as present operations were concerned, but stated emphatically that those mills which had been forced to discontinue one or two shifts would have serious difficulty in obtaining manpower to reestablish those shifts. Committee members told War Production Board officials that the log supply is still extremely critical although some relief is expected with the advent of better weather. J. Philip Boyd, director of the Lumber and Lumber Products Division, urged on the committee the necessity of complete utilization of all available logs, even to the transfer of surplus log supplies or order files. The recommendations of the committee were made following its meeting in Washington early in February.

ANHYDROUS ALUMINUM CHLORIDE

Proper flow of anhydrous aluminum chloride to consumers directly involved in production of war materials such as synthetic rubber, terpene resins, nylon, toluene, and other war chemicals has been assured by WPB through issuance of general preference order M-287. The order is effective March 15. The purpose of the order is to conserve aluminum and chlorine and to insure the smooth flow of materials from east of the Mississippi River, where estimated production is in excess of requirements, to other areas of the nation where the surplus is needed. The order provides that on and after March 15, 1943, no one may deliver or use anhydrous aluminum chloride except as specifically authorized or directed by the Director General.

FORMALDEHYDE ALLOCATED

Formaldehyde and its chemical reaction products, hexamethylenetetramine and pentaerythritol have been placed under allocation by WPB with issuance of general preference Order M-25 as amended. The title of the order was amended to read "Allocation Order M-25." The amended allocation order requires no authorization for acceptance or delivery of formaldehyde in any form or solution containing 555 lb. or less of formaldehyde by weight, 100 lb. or less of hexamethylenetetramine or 350 lb. or less of pentaerythritol under conditions set forth in the order. Persons seeking to accept delivery from producers or from distributors purchasing from producers must file application on Form PD-600 subject to instructions in the amended order. Applications should be filed in time to have copies reach the supplier and WPB on or before the 15th day of the month preceding that for which authorization is requested in cases where the supplier is a producer and by the 10th of the month where the supplier is a distributor. Producers must file application to make delivery on Form PD-601 on the 20th of the month preceding that for which authorization is requested, subject to instructions in the order. Special provisions for March allocation are included in the order.

AVAILABILITY OF MATERIALS

The nitrocellulose situation during February has eased somewhat and the same condition probably will continue in March, the Pyroxylin and Vinyl Resin Coated Paper and Fabric Industry Advisory Committee has been informed by the Chemicals Division of the War Production Board. The phenol resins situation is tight but not as critical as that in alkyd resins, the Committee was told, while the situation in all fats and oils is still critical and will undoubtedly continue so because of their need in food. Concerning vinyl resin, considerable scrap is available but there is little advantage in attempting to use it because of the difficulty of obtaining plasticizers.

MACHINERY CONTROL

Maximum Price Regulation 136, covering the sale, lease and rental of machinery and machine tools will also cover the sale and rental of used plastic molding and processing machinery, the Thermoplastic Processors Industry Advisory Committee was told today at a meeting here with WPB officials. The committee members were called in to discuss methods by which price ceilings might be established on this type of equipment, since the Plastics Division has been casting about for equipment which might be used by plants having war contracts but having inadequate facilities. A letter will go out to the entire industry in the next few days explaining that MPR 136 covers such equipment.

A representative of the Machinery Branch of OPA described the existing controls on this type of equipment, and the method of application (this is MPR 136). It is expected that a better understanding of these controls by firms in the plastics industry, accomplished through the letter which is going out immediately, will be of assistance in making additional processing facilities available for war production. As a further contribution toward solving this problem, representatives of the Machinery Section of the Chemicals Division, WPB, explained the operation of Order L-159, as amended January 29, which places both new and used plastics processing machinery under allocation control.

Application Forms Revised—Chemicals Division of WPB has announced issuance of revisions of Form PD-600 (customers' application for deliveries of chemicals) and Form PD-601 (suppliers' schedule of deliveries of chemicals). The new forms have been distributed to WPB field offices where they may be obtained by those who wish to make application to receive, use or ship those allocated chemicals which require filing of these forms. Form PD-600 has been simplified by omission of the columns which called for a summary of shipments by preference ratings and by rearranging the forms so as to facilitate filling them out. The new PD-601 calls for certain information regarding transportation, but with this exception is substantially unchanged.

• • •

Cost-plus Contracts Cut—Navy Department has announced that it will discourage use of cost-plus-fixed-fee contracts and use fixed price contracts wherever possible. One method of accomplishing this policy will be to lower the amount of the fee wherever the contractor insists on a cost-plus contract. However, the department will "continue to recognize the necessity of cost-plus contracts in certain types of experimental production," which is of interest to the plastics industry. Primary among reasons for the move is the plan to curtail the Navy cost-inspection force. Also, it was pointed out, that a fixed-price contract encourages more efficient operation.

• • •

Casein Figures Sought—Distributors and consumers of casein throughout the country have been asked for detailed figures on production and distribution of the product by WPB's plastics section. The information is necessary, it was pointed out, because of recent reductions in the potential supply of milk available for casein in 1943 and the continued shortage of shipping space from South America.

• • •

Chemical Makers Get Fuel Oil—An amendment to Petroleum Distribution Order No. 3 exempts the makers of certain chemicals, including many used in plastics, from the 40 percent cut ordered in fuel oil consumption required by the original order.

• • •

Fibrous Glass Textiles Allocated—Fibrous glass textiles have been placed under allocation by WPB in Conservation Order M-282. Products affected include rovings, yarn, cord, sleeving, tapes and cloth.

• • •

Rayon Step-up Sought—Every rayon producer in the country has been asked by WPB to step up output of rayon fiber and yarn to the maximum levels attainable with present manpower and production facilities. WPB declared it will cooperate wherever possible with industry in assuring maximum production of rayon. At the same time, OPA has issued an amendment (No. 4 to MPR 167), providing that rayon yarn producers must pass along to buyers a "substantial portion of savings experienced when certain operations in processing of yarn are eliminated." The order also requires producers to allow discounts for inferior yarns on the basis of differentials they had in effect during March 1942.

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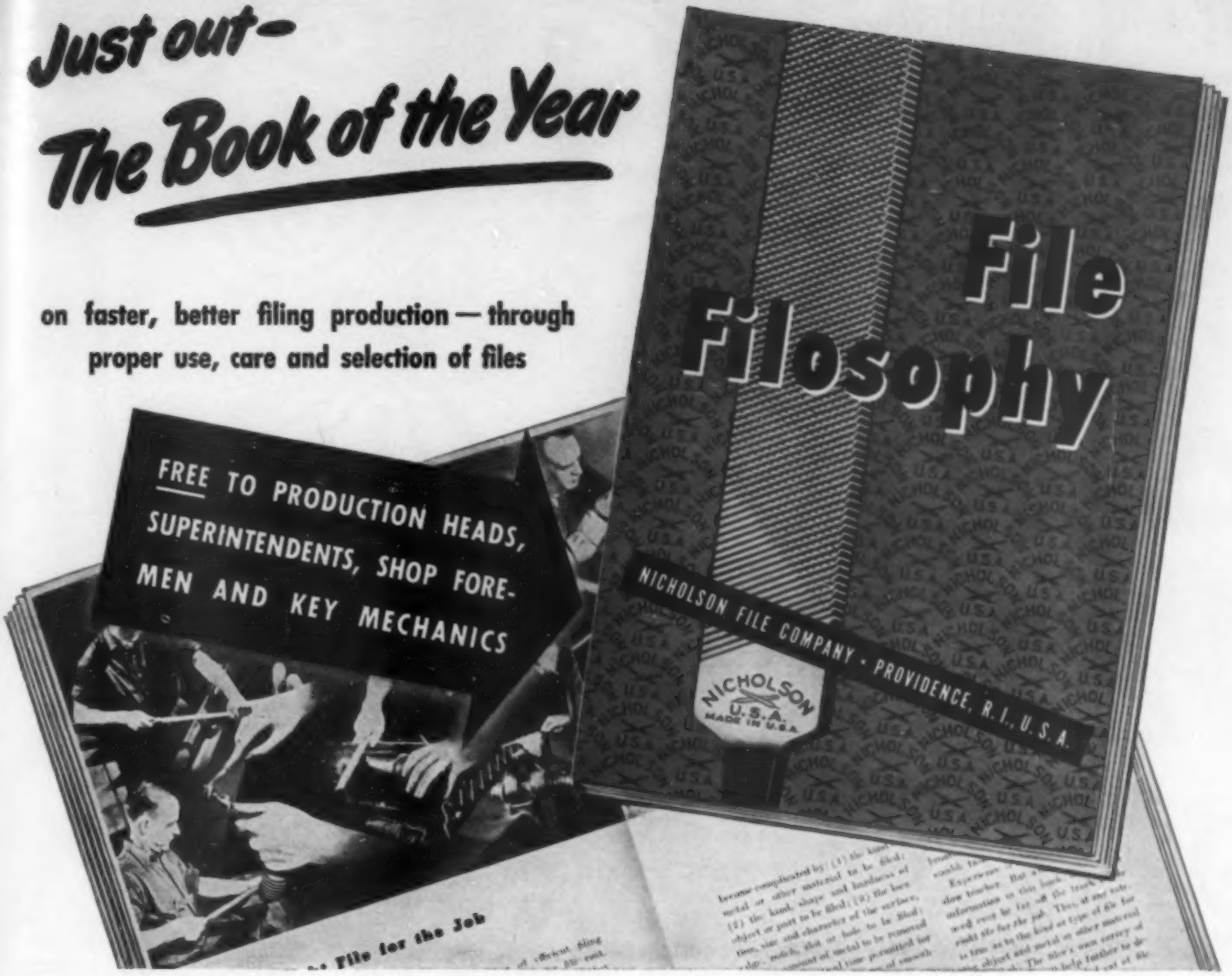

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"File Filosophy" has been prepared with infinite care. It reflects the experience of 79 years of industrial filing research, file designing and quality file manufacture. It contains the best portions of fifteen editions of a previous file treatise printed under the same title. To it has been added much of the contents of a supplemental Nicholson book, "A File for Every Purpose." Still more has been added to cover today's advances in shop practices and specialization, and new developments in materials and products.

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IN THE NEWS

★ ORIGINATING WITH A REQUEST OF THE PLASTICS BRANCH of the War Production Board, the Plastics Molders' Committee of SPI, in cooperation with the Plastics Materials Manufacturers' Association, has sent out a questionnaire to molders asking for statistics on the availability of their extrusion and injection facilities for war production, preliminary reports of which will soon be available. The WPB request was prompted by reports from the Army and Navy of inability to find manufacturing sources for the production of thermoplastic parts, and also because WPB is interested in the man-power shortage in certain areas where the output of civilian goods is still high.

The questionnaire to extrusion molders requests: 1) the number of machines available for war work, classified as to $2^1/_2$-in. screw size and under, and over $2^1/_2$-in. size; 2) whether they make their own dies; 3) whether they are in a position to accept contracts for the construction of tools and dies. The questionnaire for injection equipment requests: 1) capacity data for machines listed in amounts of under 1 oz. per shot, 2 oz., 4 oz., 6 oz., 8 oz., 9 oz., 12 oz. and over 12 oz.; 2) whether they make their own dies; and 3) whether they are in a position to accept contracts for the construction of tools and dies.

The information compiled by SPI from the returns of these questionnaires will be disseminated by WPB to the procurement offices of the Army and Navy and will be used in directing prime contractors and sub-contractors toward available facilities. The Plastics Molders' Committee of SPI plans to keep these statistics up-to-date by supplementary reports at regular intervals. In this way it may be possible to avoid the need for invoking the commandeering of equipment or concentration of facilities.

★ THE SPRING MEETING OF THE AMERICAN SOCIETY FOR Testing Materials convened at the Hotel Statler in Buffalo, N. Y., on March 3, coincident with the association's Committee Week of technical meetings. Symposiums were held on paint and on powder metallurgy, with technical papers presented and discussed by authorities in these two respective fields. Local arrangements for the meeting were in the charge of a Buffalo committee headed by B. K. McCarthy, chief metallurgist of Wickwire Spencer Steel Co., with W. H. Lutz, technical director of Pratt & Lambert as vice-chairman and T. L. Mayer, head of the Department of Technology, Buffalo Public Library, as secretary. The newly organized Western New York-Ontario District Committee sponsored the dinner.

★ THE CLOSING DATE FOR NOMINATIONS FOR THE SECOND annual John Wesley Hyatt Award has been set as March 15, according to an announcement from William T. Cruse, committee secretary, 295 Madison Ave., New York City. All individuals contributing to the plastics industry are eligible for the award, which consists of $1000 and a gold medal donated by Hercules Powder Co., manufacturer of plastics raw materials. Among those eligible are chemists, laboratory technicians, injection, compression, or transfer molders, extruders, laminators, or fabricators, manufacturers of plant equipment machinery, raw material suppliers, mold makers or mold designers, industrial designers, sculptors or other artists.

★ THE THIRD MEETING AND MONTHLY DINNER OF THE Plastics Engineers Association was held February 23 at the Hotel Bedford, New York City. Featured speakers were R. J. Metzler, Hercules Powder Co., who discussed ethylcellulose, outlining the properties of the material, methods of handling it, and military and potential civilian applications. James R. Turnbull, chief of the Thermoplastics Unit, WPB, discussed in detail the place of plastics in war production.*

It was announced at the meeting that annual dues for members would be $10.00 per year, and after nominations the following officers were elected:
President: Chris J. Groos
Vice-President: D. G. Maxwell
Secretary: C. W. Marsellus
Treasurer: Nicholas Klein

The Board of Directors is as follows:
D. C. Peterson—R. D. Werner Co.
T. A. Ryan—Bryant Electric Co.
N. G. Levien—Ivorycraft Corp.
B. Attig—American Insulator Co.
K. C. Ogden—Niagara Insul-Bake Spec. Co.
J. W. Sparks—Wadsworth Watch Case Co.
E. W. Falk—General Electric Co.

* Mr. Turnbull's speech duplicated that delivered by F. H. Carman at the S.P.I. Pacific Coast Meeting. See insert opposite page 98.

★ A MEETING OF THE CHICAGO CHAPTER OF THE SOCIETY OF Plastics Engineers was held in Chicago on Feb. 5 at the Merchants & Manufacturers Club in the Merchandise Mart. The principal speaker of the evening was W. B. Hoey, of Plastics Processes, Inc., and president of the Detroit Chapter of the Society, whose topic "Jet Molding" included an interesting review of the history of molding in the plastics field and an explanation of the application and importance of the new process. The dinner was attended by 350 guests and was preceded by the premier midwestern showing of the new sound and color film "This Plastic Age," a dramatic story of plastics produced by MODERN PLASTICS magazine. An enthusiastic plastics-minded gathering of over 500 persons was present.

★ THE PLASKON CO., TOLEDO, OHIO, ANNOUNCES THE APpointment of Whiting N. Shepard as assistant sales manager of all commercial products, in addition to his present position as advertising manager of the company. The Plaskon Co. are manufacturers of synthetic resins for molding and adhesive purposes.

★ TWO WAR TRAINING COURSES IN PLASTICS ARE NOW IN session at California Institute of Technology, Pasedena, Calif., under the direction of the Industrial Design Section of the War Training Office. Both courses, "Technology and Manufacture of Plastics" and "Plastics Applied to Aircraft," which started in January, will cover a 17-week period. There is no tuition charge and the only prerequisites are graduation from high school. In the case of the latter course, the applicant must be employed in a war industry, preferably aircraft. Antonin Heythum, lecturer in Industrial Design, is supervisor of both courses. The instructor is Dr. F. J. Krieger, research engineer, Douglas Aircraft Co. Inc., Santa Monica, California.

★ JACK SANDLER HAS JOINED THE STAFF OF AIRCRAFT PARTS Development Corp., Summit, N. J., as chief plastics engineer and will head the corporation's research work in the use of plastics in airplane construction and equipment. Mr. Sandler was formerly a plastics engineer with Northern Industrial Chemical Co. and Nixon Nitration Works.

★ A WARTIME PACKAGING CONFERENCE AND EXPOSITION will be held at the Hotel Astor, New York City, on April 13 to 16, inclusive. The extent to which the packaging, packing and shipping industries have integrated their activities with the war effort will be emphasized.

★ TRADEPRESS PUBLISHING CORP. HAS ANNOUNCED THE APpointment of Robert L. Taylor as editor of *Chemical Industries* and *Chemical Industries Buyer's Guidebook*. Mr. Taylor was formerly advertising manager of the Organic Chemicals and Merrimac Divisions of Monsanto Chemical Co. in St. Louis, Mo., and is author of the chemical industry section of the book entitled "Development of American Industry." He succeeds Walter J. Murphy who has been appointed editor of *Industrial & Engineering Chemistry* and *Chemical & Engineering News*, publications of the American Chemical Society.

★ EMPLOYEES OF THE FRANKFORD, PA., PLANT OF THE BARrett Division, Allied Chemical & Dye Corp., have been awarded the Army-Navy "E" for excellence in production of essential war chemicals, the third production award to be won by a unit of the corporation. The Barrett Division is the nation's largest producer of coal tar chemicals.

★ CEREMONIES, PRECEDED BY A PLANT INSPECTION, WERE held at Fairchild Plant No. 2 in Hagerstown, Md., on February 7 in celebration of the presentation of the Army-Navy "E" award to the employees of the Fairchild Aircraft Division of Fairchild Engine and Airplane Corp.

★ THE ARMY-NAVY "E" PRODUCTION AWARD HAS BEEN CONferred upon the employees of the Delta Mfg. Co., Milwaukee, Wis., manufacturers of machine tools, for excellence of production. The transition to wartime production has been greatly facilitated by the Delta company's peacetime operating method of mass quality production.

★ U. S. ARMY BRASS BUTTONS AND INSIGNIA ARE TO BE REplaced as expeditiously as possible by an olive-drab, non-tarnishing plastic button molded of urea-formaldehyde. Plans for the change-over contemplate that each soldier will sew the buttons on his own blouse and overcoat, and turn in the brass ones, meantime acquiring a useful knowledge of button tailoring. There are 12 buttons of two sizes on the overcoat and 10 of two sizes on the blouse. Overseas units will be the first to be supplied. The new buttons have been issued for overcoats now in the process of manufacture.

★ RECENTLY ANNOUNCED WAS THE APPOINTMENT OF J. Warren Kinsman as assistant general manager of the Organic Chemicals Department of E. I. du Pont de Nemours & Co. Inc., succeeding the late Cesare Protto. Dr. J A. Almquist will succeed Mr. Kinsman as assistant general manager of the Plastics Department.

(*Please turn to page 130*)

KUX MACHINE CO.
BUILT TO STAND THE GAFF
Kux Preform Presses
THE NEW MASSIVE MODEL 65 PRODUCES PREFORMS 3" DIAMETER, HAS A 3" DIE FILL AND APPLIES 75 TONS PRESSURE
This rugged preform press with its heavy duty, one-piece cast steel main frame will produce odd shapes as well as round preforms. The pressure applied by both top and bottom punches results in more solid, dense preforms, which have less tendency to crumble or break during handling. This new Model 65 press is built to safely withstand high pressures of up to 75 tons at top production efficiency.
Choice of a complete size range of machines in both single punch models and multiple punch rotaries is also available.
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★ AN INTERESTING PLAN FOR IMPROVED LABOR RELATIONS and a solution to the problem of absenteeism was put into effect last fall at the plant of the Boonton Molding Company in Boonton, N. J., where it is proving highly satisfactory. It started with the following note which was posted on the shop bulletin boards:

"We realize that interruption of pay for a week or more due to sickness or accident, either at the plant or outside, is a serious matter. Starting October 1st, we are guaranteeing every employee a continuous wage of 40 hours weekly at their base hourly rate.

"Human nature being what it is, there will be some chisellers. We are, therefore, engaging Mr. N. J. Burggraaf, Pastor of the First Reformed Church, to act as Personnel Manager, and visit all those who are absent for any reason. He will certify the justness of the absence. Those who are absent unfairly will not be paid, those who are will be helped in every possible way.

"It is up to the employees themselves to make this scheme successful."

The plan was received enthusiastically by the employees, to whom the ever-present fear of pay stoppage is a serious matter. In the selection of a pastor as intermediary, the company feels they made a very wise choice, for he is in an excellent position to straighten out any minor misunderstandings and at the same time to give the employee a sense of the importance of his work. Company officials are well pleased with the results.

So far the cost under this plan has been an increase of about 15 percent on the total payroll. This does not take into consideration offsetting receipts from insurance which the company carries on each individual for sickness, health and compensation. The company also carries a $1000 life insurance policy for each employee, furnishes free eye service through a local optician, and retains local lawyers for free advice.

Pay increases are based on a fixed plan system which meets present Government restrictions on pay changes. All employees are rated on job classification and individual merit rating plans as set up by the National Metal Trades Association. The development of each individual is traced and the hourly rate is increased as deserved without waiting for pay increase requests from the outside.

Another progressive step which this same company has undertaken is the institution of bi-weekly meetings for the purpose of keeping clients posted on the latest developments in the plastics industry. The meetings are held informally in the company's New York office from 5:30 to 7:30 p.m. and are adjourned to a local restaurant for detailed discussions of special problems. Only a single subject is covered at each session, and no attempt is made to limit the talk to the molding compounds used by the Boonton company. The group, which was organized last year, is limited to about two dozen people, including engineers, material specification men and designers. H. Krehbiel, vice-president of Catalin Corp., has spoken on the manufacture and possible uses of cast phenolics; Carl Whitlock, of Monsanto Chemical Co., has discussed phenolic impact materials; Robert Minbiole has dealt with Dow Chemical Co.'s saran; Fred K. Davidson, plant manager of the Boonton Molding Company, has discussed the use and design of metal inserts. These are typical subjects.

The plan has proved so successful that it is expected additional groups will be organized for inspectors, purchasing agents and other personnel who come into daily contact with plastics.

★ MOLECULE FORMATION IS THE DISTINGUISHING FACTOR between springy rubber-like substances and hard plastics or a tough fiber, either synthetic or natural, according to Dr. H. Mark, professor of organic chemistry at the Brooklyn Polytechnic Institute, in a talk to the North Carolina State College chapter of Sigma Chi at Raleigh. He explained that these substances have about the same fundamental structure and that it is their ability to crystallize that gives them different purposes. The molecules of high crystallization tend to become a typical fiber, such as nylon, silk, cotton or rayon. If the material is low in mutual molecular attraction the properties of an elastomer will predominate, as in rubber, Buna S, Neoprene, Hycar, butyl rubber, etc. Dr. Mark stated that all types of high polymers, whether rubber, plastic or fiber, have the same high order of polymerization.

Sorry!

★ THERE WAS AN ERROR IN THE 1943 PLASTICS CATALOG REferring to Maximum Price Regulation No. 136 for machinery and equipment on page 77, in relation to the base date. The given date of March 31, 1942, refers only to those items listed in Appendix B of the Regulation, as amended. All items listed in Appendix A of the Regulation, as amended, must not exceed the prices which prevailed on October 1, 1941.

★ THE WORD "COLUMBIA" SHOULD BE DELETED FROM THE bottom of the first column on trade names in the chart of "Chemical Formulae of Plastics, Resins, and Synthetic Rubbers" in the 1943 PLASTICS CATALOG. It has been brought to our attention that the resin-forming reaction shown in the chart opposite that name is not applicable to the products which have been announced under that trade name.

★ "THE PRESENT STATE OF THE KINETIC THEORY OF RUBber Elasticity" is the subject of a research conference to be held at Polytechnic Institute of Brooklyn on April 3. The conference is sponsored jointly by the Polytechnic Institute and the Society of Rheology.

★ THE PRINTING MATERIALS DIV. OF BAKELITE CORP., UNIT of Union Carbide and Carbon Corp., has moved its offices from 300 Madison Ave., New York City, to 285 Madison Ave., New York City.

★ CAPTAIN NELSON W. PICKERING, USNR, PRESIDENT OF Farrel-Birmingham Co., Inc., of Ansonia, Conn., and Buffalo, N. Y., since 1930, and associated with them for almost 25 years, resigned his position and reported to the U. S. Navy on Feb. 1. He has been assigned to duty as Commander of U. S. Navy Section Base at New London and Commander of local defense forces in that area.

★ ANNOUNCEMENT HAS BEEN MADE BY H. BRISTOL, PRESIdent of the Bristol Co., Waterbury, Conn., of the appointments of L. G. Beane as vice-president in charge of engineering and sales, Harry E. Beane as sales manager, and E. L. Stilson as assistant sales manager. All three men, who have been with the company since 1920, will be located at the general offices in Waterbury.

★FRANK J. SODAY HAS BEEN APPOINTED TECHNICAL DIRECtor of the Copolymer Corp. at Baton Rouge, La., having resigned his position as assistant manager of the chemical laboratory, United Gas Improvement Co., to take the new position. The Copolymer Corp. will operate the synthetic rubber plant of the Rubber Reserve Co. at Baton Rouge.

★ THE DEVELOPMENT OF TWO NEW PRODUCTS HAS BEEN announced by Bakelite Corp., unit of Union Carbide and Carbon Corp., New York City. A phenolic molding material, BM-13017, is designed especially for aircraft and automotive ignition parts. The material is natural colored and suitable for extrusion molding around inserts. BM-16034 is a phenolic molding plastic developed for long flow extrusion work and recommended for transfer molding.

★AN EXHIBITION OF CURRENT TECHNICAL BOOKS AND PERIodicals will open on April 1 at the New York Public Library. Photographs, posters, charts and manuscripts will be included in the collection which is being arranged by the Library's Science and Technology Division. The exhibition is intended to show the layman the scope and importance of technical books in the war, and should give engineers a broad view of technical work in fields other than their own.

★ THE WEDNESDAY MORNING BROADCAST PROGRAM OVER KFWB of the Los Angeles Breakfast Club, Los Angeles, Calif., was devoted to the subject of the plastics industry at its meeting on Feb. 24. Ralph Hemphill, chairman of Plastics Industries Technical Institute, presided. W. C. Goggin, outstanding electrical and chemical engineer of the Dow Chemical Co., discussed "The Future of Plastics." Dr. Gordon M. Kline, internationally known authority in the field of plastics, spoke on "Plastics in the War Effort." Dr. Allan A. Stockdale, member of the speakers' staff of the National Association of Manufacturers, contributed a talk on "Essential Victory."

★ IN CONNECTION WITH THE ENGINEERING, SCIENCE AND Management War Training program, Rutgers University, New Brunswick, N. J., is conducting a course called "Plastics Engineering." Headed by Dr. R. H. Kienle, Calco Chemical Division, American Cyanamid Co., Bound Brook, N. J., who will be assisted by Dr. A. L. Peiker and Mr. W. H. Peacock of this same company, the course will cover the preparation and compounds of all synthetic polymers now used in plastics as well as the molding, fabrication and finishing of plastic articles. The properties and testing of plastics and some of the scientific aspects of the plastic art will also be covered. The course, which began Feb. 1 will meet twice a week for 12 weeks and will be limited to 40-50 men. It is assumed that those taking the course have a Bachelor's Degree in engineering, chemistry or physics.

★ A GRADUATE COURSE, "RECENT DEVELOPMENT IN CHEMistry of Organic High Polymers," has been started at the Polytechnic Institute of Brooklyn covering the physicochemical and organic chemical aspects of recent research in the fields of natural and synthetic high polymers. Professor Mark and Dr. W. P. Hohenstein of the Institute are conducting the course in collaboration with guest lecturers. The course consists of 15 two-hour lectures with classes meeting weekly on Wednesday evenings.

MACHINERY and EQUIPMENT

★ EXTREME FLEXIBILITY IS SAID TO BE THE OUTSTANDING quality of a grinding machine announced by Berco Mfg. Co., Chicago, Ill.—the Hilco Universal Cutter-Grinder. Equipped with an interchangeable table or flat bed, it features exclusively a special universal index dividing head. Seven index circles consisting of micrometer placed holes or stops insure uniformity of cutting edges in the finished cutter. Regardless of the number of teeth or cutting surfaces, any conceivable simple or compound angle, the grinder may be quickly set up for any type cutter up to 6 in. in diameter, or any saw up to 18 in. in diameter. Suitable for tool cribs in large plants or for the individual mechanic in small shops.

★ INCREASING THE VERSATILITY OF THEIR LIFT TRUCKS, Towmotor Co., Cleveland, Ohio, have added a crane-arm attachment to speed the handling of specialized applications. The attachment, which may be used with or without forks, is quickly demountable and interchangeable with standard forks.

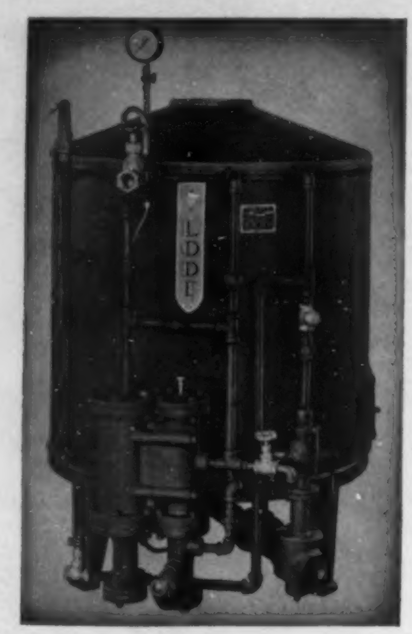
★ WATSON-STILLMAN CO., OF ROSELLE, N. J., ANNOUNCE A new motor-driven starting pump for high pressures. Designed for primary or auxiliary starting of marine and stationary diesel engines, the pump also serves for testing or operation of hydraulic presses. It is a 2-plunger vertical unit with $^{3}/_{4}$-in. diameter plungers having a $1^{1}/_{2}$-in. stroke; has a 2-h.p. motor with drive of 720 r.p.m., and develops a pressure of 4000 p.s.i. It delivers 130 cu. in. per min., at 100 r.p.m. Tank capacity is 20 gallons.

★ SMALL IN SIZE (32-IN. HIGH), THE DILLON MODEL B TENsile tester handles a loading range up to 10,000 lb. and will check specimens up to 12 in. in length and 9 in. in width. W. C. Dillon & Co., Inc., Chicago, Ill., manufacturers, report that wood, metal, rubber, plastics, etc., can be readily tested for any tensile property. Grips can be had for special tests such as separation pull of sockets, etc. The illustration (above) shows a wood stress test, vertical to the grain. The versatility of this instrument is largely due to the dynamometer stress indicator which permits wide limits of measurement with a uniformly small stress-reader.

★ WILBERTON COMBINATION MASTER SURFACE-ANGLE Plates offer an inspection device of sturdy construction, unobstructed clearance and a guaranteed tolerance within .0001 inch. The angle-plate is hand scraped parallel to the surface plate and elongated slats permit the use, in most instances, of draw studs for holding the work in position without strain. Made by Thomas Wilberton & Co., Cedar Grove, N. J.

★ A HARDENED THREAD-FORMING SCREW DEVELOPED BY Continental Screw Co., New Bedford, Mass., offers an innovation in self-alignment and holding action provided by a smooth pilot point below tapered threads, particularly convenient for screws inserted at an angle or upside down. A slotted opening at the entering end makes a self-cutting edge and gives "spring." The screw is claimed to stay tight under vibration.

★ OPERATING UNDER A NEW PRINCIPLE OF WATER FEEDING, the Lodi steam generator (below) needs only fuel and water for automatic operation, as announced by Super Mold Corp., Lodi, Cal. Accurate heat and water balance is maintained by automatic jet control; no thermostats or motor driven pumps are needed and firebox, pit and electrical connections are also eliminated. The generator has only 3 working parts and is said to be explosion proof. Burners are provided for either gas or oil fuel. The 10-h.p. model claims 150 lb. pressure from a cold start in less than 5 minutes.



★ A LIFT CARRIER WITH BUILT-IN BRAKE FOR SMOOTHER performance in material handling has been announced by Ernst Carrier Sales Co., Buffalo, N. Y. Provided with a patented lifting device for placing and removing 55-gallon drums on and off skids, scales and platforms, the carrier can be operated by one man without need of touching the container. To raise the container to the top 14-in. position, the handle is lowered to the horizontal position where it automatically locks. Lowering is accomplished by unlocking the handle and applying the brake.

★ TWO NEW COMPACT, PORTABLE COOLANT PUMPS ADAPTED to almost any machine tool have been announced by Atlas Press Co., Kalamazoo, Mich. Centrifugal design increases rigidity and insures smooth performance. No priming is necessary. Complete systems may be assembled by selecting feed and return units available.

★ A NEW HYDRAULIC ARBOR PRESS IS ANNOUNCED BY Hydraulic Machinery, Inc., Detroit, Mich. Rated 6-ton, with maximum 8-in. stroke, 20-in. opening, the press and power unit are combined in one compact piece. Control centers at a lever-operated valve which determines the speed and movement. The 5-hp. motor is directly connected (above).

LONDON LETTER

LAMINATES

These have since the outbreak of war found many new applications in British industry, particularly the armament industry. In the manufacture of service aircraft, for instance, laminates find literally hundreds of applications, e.g., controls such as Teleflex, fairlead pulleys and guides, conduits for electrical wiring, aerial masts, instrument panels and supports. Still one of the most interesting applications of laminated material is the collar fitted to the root of hydromatic airscrew blades. This collar is built up of fabric impregnated with phenol-formaldehyde resin and is designed specially to allow the use of a hub barrel oil seal without fretting the blade shank and causing high stress concentrations due to the pitch charge movement of the blade against the seal.

Special laminated sheet is also used for strengthening wood members in trainer aircraft construction where the ends of the members are subject to heavy shearing or bearing forces. Typical examples of one of the uses of this particular type of laminated sheet (F.5522) is that of joining wing spars to the fuselage in lightweight wooden aircraft construction. The material possesses a very high bearing strength, permissible loading being 25,000 lb. per sq. inch. Inserts of F.5522 are easily slotted into the wooden members and glued in position. Other interesting aeronautical applications of laminated sheeting are in the form of fairleads and insulators to prevent corrosion of metal parts, particularly contacting edges of an all metal assembly. In the modern aircraft transmitter-receiver, over a dozen uses are now found for laminated sheets and tubes, etc., the best known laminated component being rotor contact plates.

Apart from the aircraft industry (to date the most prolific user of laminated plastics), applications in the war-converted automobile and tank factories, ship-building yards and the war-swollen electrical trades, rolling mills, etc., increase almost daily. The demand tor laminates greatly exceeds the supply, and the longer the war continues the greater will be the difference between the two. Continuous research has had to be carried on to meet the new requirements of the vital war industries which, owing to shortage of scarce non-ferrous metals, have turned to plastics for certain types of materials, or looked to plastics to solve certain technical problems which other familiar materials cannot solve.

Britain is fortunate in the fact that, prior to the outbreak of war, laminated materials were well developed and their unique properties not unknown to industry generally. Approximately half a dozen firms were manufacturing laminates in 1939 and since that time production has been greatly stepped up.

British Standard Specification 972 of 1941 names three principal types of laminates:

1. *Type A*. Number of threads per inch, warp and weft, is greater than 100. This material has the highest mechanical strength and best machining and punching properties. Range of thickness normally available from $^1/_{64}$ in. to 4 inches.
2. *Type B*. Number of threads per inch, warp and weft is greater than 45 and less than 100. The mechanical strength and machining and punching properties of the material are intermediate between those of Types A and C. Range of thickness normally available is from $^1/_{32}$ in. up to 4 inches.
3. *Type C*. Number of threads per inch, warp and weft, is not less than 35 and does not exceed 45. The mechanical strength and machining and punching properties of the material are not as good as those of Type B. Range of thickness normally available is from $^1/_{32}$ in. to 4 inches.

The minimum tensile strength for Type A material must, according to the above specification, be 14,000 lb. per sq. in., while the tensile strength for Type B is 10,500 and for C, 9,000 lb. per sq. inch. The range of tensile strength for the two best-known laminates produced in the United Kingdom are 12,500–16,500 and 8000–11,000.

British manufacturers use various types of material for the laminae of sheets, tubes, etc.—various grades of cotton, linen or canvas, asbestos cloth, glass fabric, etc. A general method of producing sheets is to pass the laminae through an impregnating machine in which they absorb a predetermined quantity of synthetic resin in alcoholic solution. The sheets when dry are cut to size, stacked between polished steel plates in a large daylight press and cured. Tubes are usually produced in two grades, wrapped or molded.

Since the outbreak of hostilities, considerable interest has been taken in the use of semi-cured laminated sheets which, when heated, can be formed with inexpensive tools. Only simple curvatures are possible lest the material be ruptured. Thickness of semi-cured sheets varies from $^1/_{32}$ in. to $^1/_8$ inch. Characteristic properties of molded laminated parts are high tensile and impact strength, which render them very suitable for numerous aeronautical applications, such as bucket seats for pilots and air crews in heavy bombers.

For some years now an important type of laminated insulating material made with aniline formaldehyde resin has been manufactured in Great Britain for applications necessitating very high electrical and mechanical properties and also high non-tracking properties. This particular laminate, which is made from a special paper in which the aniline formaldehyde resin is brought into intimate association with the paper fibers by its precipitation in the pulp prior to the manufacture of the paper, is proving of the greatest value to the British electrical industries, now much expanded to cater to the needs of radio-location and radio telephony, etc. The tensile strength of this aniline formaldehyde resin laminated sheet is 15,000 lb. per sq. in. and its breakdown along laminae (1-in. length, minute value at 90° C.) is 60,000 volts.

So far not much progress has been made in the development of glass fiber laminates similar to the Owens-Corning "Fiberglas," but early in the war a vitreo-plastic known as "Luxoid" (laminated sheet made by impregnating specially prepared glass tissues with a thermoplastic resin) was produced experimentally and appeared to offer many interesting possibilities.

Of interest is a new cement developed by Aero Research, Ltd., in 1940 for joining phenol-formaldehyde and urea-formaldehyde laminated materials and moldings. The shear strength of the joint is claimed to exceed that of the parent material. This new cement is a suspension of a powder in a highly reactive synthetic resin. It is applied to the surfaces to be joined, which are then left for a few minutes to become tacky and finally clamped together with an ordinary G. clamp. The joint is then heated to not less than 140° C. (284° F.). Although the cement has no specific adhesion for metals, it can be used with great success to secure metal inserts into moldings and laminated sheets if the root end of the metal insert is knurled. The necessary hole can be drilled or made in the molding operation.

Before terminating this brief survey of laminated materials in Britain's war industries, it should be mentioned that considerable interest has, during the last two years, been taken in thermoplastic laminates, and types of cellulose acetate with a fabric base have been produced for special aeronautical applications, e.g., fuel tanks. The new laminated material, known as Pytram, which was originally produced for lightly stressed units, appears to have great possibilities. From the results of tests carried out by the Royal Aircraft Establishment and published in *Flight*, Oct. 1, 1942, Pytram offers interesting possibilities.

Density, 4 lb./cu. ft.; Specific gravity, 0.77
Tensile strength, 3900 p.s.i.; Bolt-hole tensile strength, 4020 p.s.i.
Shear strength, 2000–3000 p.s.i.
Temperature range, satisfactory from −70° C. to +130° C.
Water absorption, 1.92 percent.
Modulus of rupture bending, 5960 p.s.i. *(Please turn to next page)*

RESIN-TREATED (LAMINATED) IMPROVED WOOD

Prior to the outbreak of war, resin-impregnated and compressed wood was used almost exclusively for electrical applications where high dielectric strength coupled with good mechanical properties were needed. The war presented new opportunities for this material, and it soon became of interest to aircraft manufacturers for large components, e.g., airscrews, fuselages, and also for aerial mast bases, small radio housings, aircraft radio panels, and to the vast metal-working industries for press tools.

For small quantity production, i.e., series of 1 to 2000, these resin-impregnated wooden tools possess several important advantages over standard hardened steel castings. Although pound for pound the improved wood is more expensive than the metal, in actual production of tools the wood is more economical, as pattern making, molding, etc., are eliminated and blocks of the non-metallic material can be machined straight away, after seasoning, with ordinary metal working tools, or even wood-working tools if special working precautions are taken. It is as well to stress the fact, however, that for long runs (20,000 or so) the wooden press tools are not suitable; but for the numbers required in modern aircraft production they fulfill all needs.

The average life of an improved press forming tool is 2000 to 2500, but even when the tool shows signs of wear it need not be scrapped as it is possible to build it up for re-use. Tools are constantly being patched up for another lease of life, that is, for another 500 to 750 or 1000 pressings. This rejuvenation is of the greatest importance in wartime when all delays must necessarily be reduced to a minimum. Recent complaints that the wood begins to foliate after use cannot be accepted as a general condemnation of the material, but rather as a significant revelation of its shortcomings, if manufacturing conditions have not been properly regulated to meet demands of service.

The above figures and data refer, of course, to cold pressings, but for hot pressings up to 300° C. a good laminated wood tool should be able to produce runs of 500 to 700 without injury. It must be remembered that wood is not a perfectly homogeneous substance like steel and uncertain stresses are likely to be set up in the material. Unless adequate time is allowed for the release of these stresses, slight deformation may take place.

The practical advantages claimed for these impregnated wood press tools by users are several. In the first place, as laminated wood is less than $^1/_4$ the weight of steel, it requires less labor to handle during machining and also to set up presses. Now that female labor is being employed to a very large extent in aircraft factories, this is a consideration of growing importance. Another important advantage of the new wooden type of press tool is that, unlike metal, it can be easily modified during production; whereas in the case of steel, changes in design usually entail the ordering of fresh tools. This may mean a delay in production at a time when the services are calling for peak production figures. At the present time, large numbers of blanking tools are being made of resin-impregnated wood. In tools of this kind, punch and die are faced with a mild steel plate which provides the cutting edge. In forming tools, also, steel inserts are incorporated in the dies at points where exceptionally heavy wear is to be expected, such as on sharp corners or where severe curvatures are required. (*John S. Trevor.*)

Modern plumbing fixtures

(Continued from page 84)

The "over the rim" tub filler meets wartime rush building needs. Some improvisations are necessary to speed construction, and one of them makes use of the over the rim filler. The supply pipes are left protruding from the wall for the plumbing installations. Saran connections are made by the plumber when the fixtures are installed leading to the over the rim filler. Brass valves control the flow of water.

Such an installation is admittedly a war emergency measure. But again, looking ahead, a simple set of replacement parts has been designed to allow those war installations which prove permanent to be modernized. The over the rim filler can thus be transformed into a decorative, up-to-date fixture. The cover plate and other postwar parts, when completely installed with the original war emergency parts, cost about 50 percent as much as brass fixtures.

Closet tank floats and balls subject to constant immersion are injection molded from polystyrene in sections and assembled. In selecting the materials for the floats, the lightness of styrene was a factor considered as well as its moisture-resistant properties. On the design of the moldings, special attention was devoted to the junction of the threaded rod with the female thread in the plastic float. It was at this point that the old copper balls and the first plastic floats failed, as the strain was centered at the thread. Proper design based on the functional needs of the float has overcome this difficulty in the modern plastic float.

Other plastic items manufactured for the building trade and home owners include plastic S and J tubes and drains, complete with plastic nuts for quick installation. Not only are traps and drains supplied but also the supply lines for lavatory, shower, tub and basin, and line of plastic stoppers to replace conventional rubber drain stoppers. A plastic ring is provided in each stopper for the draw chain.

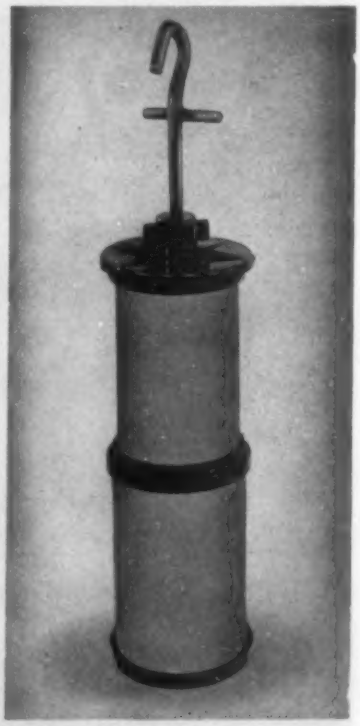
The modern bathroom, regardless of the price range, will include a wide variety of plastic parts. As war restrictions are lifted, the purely decorative aspects of plastics will be increasingly stressed, and new plastic fixtures will be designed to please the thrifty home owner and the fastidious as well.

Electroplating masks

(Continued from page 79) designed. The lifting bar was screwed through the cover plates and sleeves and connected to the lower plate. Complete protection was given the half-inch areas on each cylinder. Here one masking unit did the work of two (Fig. 6).

According to J. W. Higgins, Packard chemist in charge of all plating, who has been an active pioneer in the adoption of plastic masking for his company, this masking operation effected a tremendous saving in time and material and the use of the plastic helped Packard to maintain production schedules and to turn out war tools.

The importance of plastic masking fixtures to all companies engaged in electroplating operations cannot be stressed too highly, for the material's unusual dimensional stability and chemical inertness, together with its resiliency and resistance to heat, mark it as the answer to a wide variety of masking problems confronting industry.

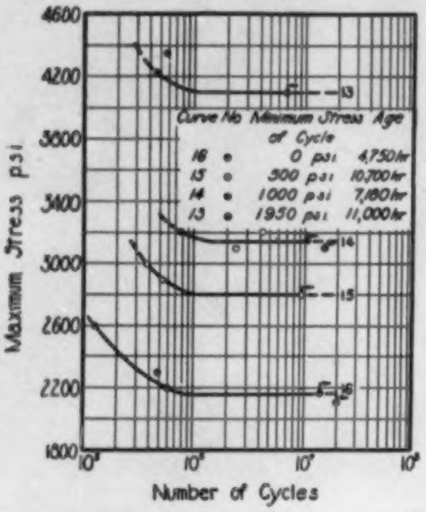


6—Saran masking unit protects areas at top and bottom of two cylinder sleeves during nickel plating.

Mechanical tests of acetate

(*Continued from page 105*) material was found to be decreased by the rise in temperature of the specimen resulting from internal friction.

10. The speed of testing was found to affect the endurance limit of the material. The endurance limit decreased with increasing testing frequency up to 750 cycles per minute. From there on to 2900 cycles per min. the endurance limit was constant.



15—*σ — N diagrams for several different ranges of stress*

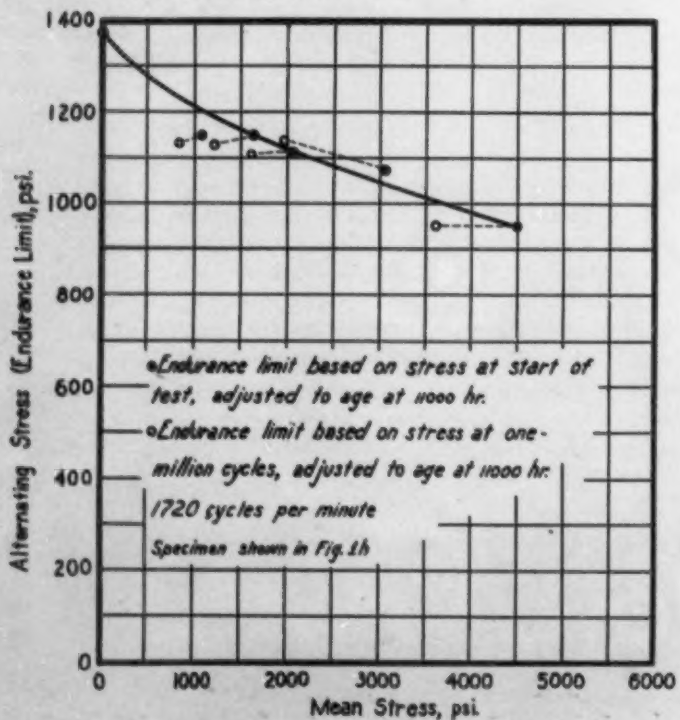
11. A change in the range of stress was found to cause a decrease in the endurance limit (defined in terms of the alternating component of the stress cycle) as the mean stress of the cycle becomes larger, for values of mean stress in tension.

Acknowledgments

The tests reported in this paper were a part of the work of the Engineering Experiment Station of the University of Illinois, Dean M. L. Enger, director, in the Department of Theoretical and Applied Mechanics of which F. B. Seely is head. The author is indebted to F. B. Seely and H. F. Moore for their suggestions and criticisms during the conduct of these tests and the preparation of this paper. The tension, compression and torsion tests were a part of a senior thesis by B. J. Farrell performed under the author's direction. A portion of the fatigue tests reported in this paper were performed as part of a senior thesis by J. W. Lessner under the author's direction. The following student test assistants are to be commended for their interest and the care with which their work was done: O. E. Hintz, R. V. Chase, W. J. Worley and L. E. Lambert.

Acknowledgment is made to the Plastics Division of Monsanto Chemical Co. for the material supplied. The author is indebted also to the U. S. Regional Soybean Laboratory, formerly at the University of Illinois, for the loan of certain equipment.

16—*Effect of mean stress on endurance limit for different ranges of stress*



Paper laminates

(*Continued from page 91*) The principal change in design involved the elimination as far as possible of changes in cross section of the part being substituted, the object being to have continuous laminae throughout the structure.

Generally speaking, most of the parts can be made in the alloy molds, but if the runs are large, the parts reasonably large, and the mold costs can be amortized, a steel mold is then in order.

A later development of Brunsalloy was for the construction of panel stock of great rigidity which would be flat. The conception of flatness generally held with regard to laminated sheet stock is inadequate when considered in relation to flat material for the mounting of instruments. In most applications, it is necessary that the panel be supported on shock mountings, such as Lord rubber mountings. In the aircraft industry, in the interest of reduction of weight, these mountings are usually quite small and the movement of the mounting is negligible with relation to the size of the panel.

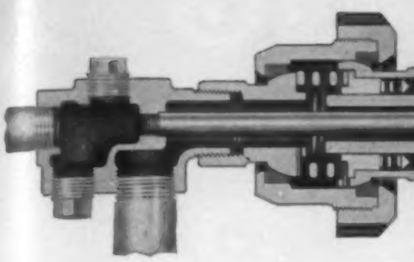
Obviously any distortion of the panel itself might exceed the amount of movement provided for in the mounting, and therefore in assembly would completely throw the mounting out of alignment and prevent it from functioning as it should.

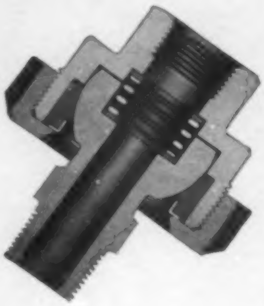
Allowable warpage is a matter of 1 percent and it is desirable to have it as much less as possible. To accomplish this, Brunsalloy ACB-3 was developed. This is a material with great rigidity and vastly improved physical properties which give it an extremely high loading factor. The stress-weight ratio compared to aluminum is favorable. This table of values was obtained on a production run of flat stock molded at 700 p.s.i. with a long-fiber paper base, a low-pressure laminating resin, and interlaminating birch plywood with paper:

Specific gravity	1.24
Tensile strength	20,000 p.s.i. parallel to the two longitudinal plies
Tensile strength	17,500 p.s.i. parallel to the one cross ply
Compressive strength	15,000 p.s.i. parallel to the two longitudinal plies
Compressive strength	11,000 p.s.i. parallel to the one cross ply
Modulus of elasticity	1,800,000 p.s.i. parallel to the two longitudinal plies
Modulus of elasticity	1,400,000 p.s.i. parallel to the one cross ply
Impact to break $^3/_{16}$-in. × $^1/_2$-in. unnotched specimen	.97 ft./lb., flatwise, two longitudinal plies
Impact to break $^3/_{16}$-in. × $^1/_2$-in. unnotched specimen	.89 ft. lb., one cross ply

The construction consisted of three plies of plywood with intermediate plies of paper and outer plies of paper. In the table, the reference to longitudinal plies refers to the wood plies and not to the grain of the paper. In this construction, the grain of the paper is parallel to the two outer wood plies.

It has been found necessary to keep the flatness within the desired limits, to balance the paper and wood plies within fairly narrow limits, and it is necessary for each thickness of panel, by trial and error, to obtain a combination of veneer thickness and paper thickness which will give the optimum flatness. (*Please turn to next page*)





Combination and Single Purpose Instruments

Following the development of flat panels of Brunsalloy ACB-3 with these characteristics, a need for tubes arose, and after considerable experimentation it was found possible to make them of the same material. The particular application involved a required low deflection under catenary loading of the tube, and the particular tube of necessity had to be constructed with a relatively thin wall.

The tube construction involved veneers of longitudinal grain only, built up in wall thickness of $^1/_8$ in. and an outside diameter of $2^1/_2$ inches. The catenary loading of the tube was approximately 100 lb. and the allowable deflection $^1/_{16}$ inch. Unfortunately, it is not now possible to disclose the method of constructing the tube.

Figures 1 and 2 are representations of the possible applications of Brunsalloy AC and Brunsalloy ACB-3. Figure 1 shows lengths of tubing made of the interlaminated birch and paper material. In Fig. 2 the piece with three recesses compresses Brunsalloy AC, plywood and metal into an assembly of strength and light weight. The inert nature of laminated material together with a high degree of impermeability makes it extremely difficult to fasten it together with any glue or cement, and has necessitated other methods to secure the desired results.

Here it was necessary to fasten a doubler on the underside of the piece, and not desirable to use rivets. To solve this problem, experimentation led to a method of curing plywood directly onto the paper laminate. During the molding operation enough resin in the laminate penetrates the surface of the plywood to make a strong and durable bond, but does not penetrate the entire thickness of the plywood, leaving the outside of the plywood to be glued with ordinary glues. In Fig. 2 the location of these plywood strips can be seen in the bottom of the recesses of the piece at the top. The strips themselves are on the underside of the recesses. At the extreme lower right-hand corner is a drain tray which has a section of copper tubing molded into the bottom to allow the attachment of the drain tube. The section of tubing is flanged and permanently cured into the paper laminate.

Although not visible in the photograph, the attachment is at the hole location which can be seen in the bottom of the piece. The holes and slots in the piece at the left of the illustration are cut into the paper laminate after molding by a machining method.

Yarn for screens

(Continued from page 70) the consumer field for attractive ladies' handbags,† belts, suspenders, upholstery fabrics, novelty jewelry and shoe fabric.

While the screen cloth is one of the outstanding industrial applications for the woven plastic-coated yarn at present, this material is being tested for conveyor belts and trays in the food dehydrating industry, as sieves for chemical powder, and for other industrial uses such as milk and butter screens, cement screens, etc. While these are all metal replacements, it may also be possible to weave a screen cloth combining wire and the plastic yarn, holding the amount of wire to a minimum. This may produce a more durable and economical industrial screen.

In comparison to wire screen cloth, the present cost of the woven plastic yarn is high. With more extensive, standardized production, it is expected that the overall cost of the plastic screen cloth will be considerably reduced. According to test reports, the plastic yarn has a life expectancy of about two years under normal conditions, but the material has not yet been tested for wearing qualities over a longer period. Thus it cannot at present be compared with ordinary black-painted wire screen, which is said to last seven years under the same conditions. At the present time, when workability and availability are prime factors, this latter condition is outweighed by expediency and the usefulness and physical properties of the material. When the screen yarn can be made in the multitude of colors and varying degrees of translucency possible with plastics, the plastic-coated woven product will be extremely desirable for postwar home and decorative uses.

Credits—Material: Plexon by Freydberg Bros.-Strauss. Screen woven by Hanover Wire Cloth Co.

† See MODERN PLASTICS *19*, 55 (May 1942).

Synthetic rubber

(*Continued from page 108*)

The Baruch Committee stated that the minimum stockpile which we should carry is 120,000 long tons, which added to 211,000 means the absolute minimum for 1943 production is 330,000 long tons.

The program for this synthetic rubber production this year is lagging behind from 30 days to 3 months, depending on the source of information.

UNITED STATES RUBBER PRODUCTION CAPACITY (LONG TONS)

	1942	Estimated 1943	Estimated 1944 (sometime)
Buna S	60,000	400,000*	850,000*
Buna N	18,000	20,000	25,000
Butyl	7,000	62,000*	132,000*
Neoprene	19,000	30,000*	69,000*
Thiokol	3,000	24,000	60,000*
Vinyl polymers	30,000	40,000	50,000
	137,000	566,000	1,186,000

* Baruch recommendations.

The normal United States consumption is 600,000 long tons. If the total estimated production for 1944 is carried out, 197 percent of the normal consumption of rubber will be represented.

In conclusion, what are the prospects for meeting this program? It will be a miracle if the entire program can be completed by the end of 1943 as originally scheduled. Industry has had to go into synthetic rubber production with a minimum of pilot plant experience. In spite of the press reports, the chemists and other scientific men and workers on the program are all doing a grand job, working 6 to 7 days a week and up to 12 hours a day and, if the program can be carried, they will do it.

If the war lasts 2 or 3 years, we will have a well-established synthetic rubber industry. We may expect greatly improved polymers. The price competition between natural and synthetic rubbers will be keen, and will depend finally upon the wage for which the coolie will be willing to work after the war. There will probably be an over-production of rubbers, both natural and synthetic, which will have to be handled by devising new uses for rubber. Never again will we have to pay cartel prices on natural rubber, as we have been paying since 1922. The impact of this development is going to have profound political and economic repercussions on our relationship with South America, Great Britain and the Dutch.

Instrument life

(*Continued from page 97*) obtained by use of a diaphragm seal mounted below the gage, with the Bourdon tube of the instrument and upper diaphragm housing filled with glycerin or oil.

Fluid pulsation protection

Fluid pulsation is another cause of inaccuracies and short life of pressure instruments. In the majority of molding equipment the hydraulic line pressures are indicated, either at each piece of equipment or at several points in the plant. When control valves are opened or closed, there is heavy water hammer in the entire system. This surge will naturally be felt by every pressure instrument which is connected to this line. A rapidly pulsating pressure will destroy the accuracy of the delicate sector-and-pinion movement by wearing the gage teeth and bearings. A shut-off valve placed ahead of the gage, and throttled until the pulsation disappears, will overcome this condition, but may result in clogging of this very small opening. Gage snubbers have been introduced to provide the same result. One type employs a large number of small passageways with changes in direction; in another, the inertia of a moving piston prevents rapid pulsation, while a third type employs a rubber diaphragm with the gage tube filled with glycerin, the latter throttled by passing through a felt retainer.

Over-range protection

Be sure that the instrument has ample over-range protection to prevent blow-out at any pressure likely to be applied to the equipment or line. It is good practice to allow a margin of 100 percent more range than necessary to measure normal operation pressures.

Long-time tension test

(*Continued from page 106*)

(*b*) When testing materials which may be suspected of anisotropy, duplicate sets of test specimens shall be prepared, one set with the long axis parallel to the direction of anisotropy, and another set with the long axis normal to the direction of anisotropy.

(*c*) All surfaces of the specimens shall be free from visible flaws, imperfections or scratches. Marks left by coarse machining operations shall be carefully removed with a fine file, and the filed surfaces shall then be smoothed with No. 00 or finer abrasive paper. The finishing file strokes or sanding strokes shall be made in a direction parallel to the long axis of the test specimen. All flaws shall be removed from molded specimens, great care being taken not to disturb the molded surfaces.

NOTE. Before testing, all transparent specimens should be given a polariscope inspection and those which show typical or concentrated strain patterns should be rejected unless these "initial" strains constitute a variable whose effect it is desired to study.

(*d*) Gage mark areas should be placed on the specimen with china marking pencil, soft fine crayon or with India ink. Gage marks may be scratched in the markings but only when care is taken to avoid injuring the surface of the specimen, since such scratches may cause erroneous results due to the concentrations of stresses.

Number of test specimens

6. (*a*) At least three specimens shall be tested for each sample in the case of isotropic materials.

(*b*) Six specimens, three normal and three parallel with the principal axis of anisotropy, shall be tested for each sample in the case of anisotropic materials.

(*c*) Specimens that fracture at some obvious fortuitous flaw or that do not break between the predetermined gage marks shall be discarded and another specimen substituted.

Conditioning test specimens

7. Test specimens from materials of classes A and C should be allowed to approach test conditions by remaining in the test room prior to test for at least 4 days. Test specimens from materials of classes B and D should be allowed to approach test conditions by remaining in the test room prior to test for at least 24 hours.

Procedure

8. (*a*) The specimens should preferably be tested in an atmosphere maintained at 25° ± 1° C. (77° ± 2° F.) and 50 ± 2 percent relative humidity.

(*b*) The test specimen should be placed in the grips, care being taken not to apply too much tightening pressure but just enough to prevent slippage during the test. The metal flap which is part of the grip should not be tightened too much in order to enable the load to be axially distributed.

(*c*) Throughout the duration of the test, observations of extension should be made at sufficiently frequent intervals to define an extension-time curve.

(*d*) After unloading, a certain amount of prolonged plastic recovery may occur in addition to the elastic recovery. This plastic recovery may be recorded.

(*e*) The tensile stresses used may be any percentage of the ultimate tensile strength or fixed load agreed upon by the seller and the purchaser.

Plotting of results

9. (*a*) Extension-time curves may be plotted on semilogarithmic paper with time as the abscissa, and unit extension as the ordinate. Many useful relationships may be obtained from such a curve such as the ratio of the percentage extension to a constant number of hours or the time required to produce a definite percentage extension.

(*b*) For each series of tests the arithmetic means of all ultimate extension values obtained should be calculated to three significant figures and recorded as the average result for the particular values in question.

(*c*) The deviation of each value from the average value should be

calculated and the arithmetic means of these deviations determined. This value should be recorded to three significant figures as the average deviation of the particular series of results.

Report

10. The report shall include the following:
(1) Date of test,
(2) The complete identification of the material tested, including type, source, manufacturer's code numbers, form, principal dimensions and previous history,
(3) Dimensions of the test specimen,
(4) Number of specimens tested,
(5) Method of preparing test specimens,
(6) Preconditioning procedure used,
(7) Atmospheric conditions during the test,
(8) Tensile load applied to test specimen, and
(9) Average ultimate percentage extension for the period of time used in the test as agreed upon (Section 8 (e)).

Vinyl compound

(Continued from page 86) extruded, cast or calendered, or placed in solution with solvents for use as a dip coating or paint. It may be compounded to be resistant to all inorganic acids (except fuming nitric), all inorganic salts, all organic acids (except glacial acetic), alkali solutions and most of the hydrocarbons and solvents. It is unaffected by mineral oils, gasolines, fresh or salt waters.

One of the newer formulations, designated as Tygon "F," is made entirely from agricultural waste materials such as furfural. This particular composition may be molded, cast or formed into a liquid with inexpensive solvents for use as a surface coating for concrete, steel or wood, or for impregnation of fabrics, paper or other fibrous materials.

The compound, as compared to rubber, has many of the latter's physical characteristics and several advantages. Some of the formulas have the amazing ability to retain their flexibility at temperatures 90° F. below zero—far below the range of natural or synthetic rubber. Where rolls of this plastic have replaced rubber, a better deterioration and aging resistance has been claimed, and a service life of many months as opposed to a life of less than a week for rubber. In comparison tests on vibrating automatic machines where tubing undergoes continuous twisting, flexing and pulling, it has shown a "flex" life 10 to 12 times that of rubber.

The field of service of the material is primarily where usage requires a protective coating of unusual efficiency and durability, such as for tank linings, pipe coatings, valve diaphragms, gaskets, coating for plating hooks and thermocouples, lining for fans and ventilating equipment, insulation and tubing. It also acts as a shatter-resistant coating for glass, applied as a solution with spray or brush.

4—Glass coated with a solution of the vinyl material is rendered shatter-proof. When the glass is dealt a heavy blow, the flexible plastic film keeps broken pieces from flying apart

PHOTO, U. S. STONEWARE CO.

Control sheaves

(*Continued from page 94*) out splits and piece by the use of knock-out pins is also shown. Ample loading space has been provided for high bulk factor (impact material) so that if woodflour phenolic did not give sufficient strength to the sheave, the impact material could be substituted with no tool change. This matter of loading space is very often neglected in tool design. It should be given serious thought by both the buyer and molder for it has been the cause of many new expensive molds being constructed when high bulk factor materials have been substituted for those of low bulk factor. Many reasons account for this change, such as new uses calling for greater strength than was originally needed, certain specification changes which were not anticipated when the part was designed, as well as the use of some of the non-priority materials which are now coming into use. A great number of the later materials have such a high bulk factor as to prohibit their use in many molds without expensive preforming.

The machine tool company's experience with these plastic sheaves is of but recent date; however, they report that their problem in this case has been very nicely solved by this plastic replacement of lightweight metal alloys. It is very doubtful that the company will ever return to metal sheaves, even if these materials ever again become easily available, because the plastic material has numerous advantages which the metal product does not offer, some of which are listed below:

1. Low material cost.
2. Elimination of machining operations.
3. Much lower selling price.
4. Variety of colors and compositions for various other applications in the insulated wire and other fields.
5. Ability to stock these sheaves in moderate quantities for rapid replacement service.

On the other hand, the company recognizes that the above advantages have been countered by some disadvantages, such as:

1. High die cost.

(*Please turn to next page*)

5—Filing the fin from the parting lines of this control sheave is the only operation necessary for finishing it, as the splits are held in perfect alignment during the molding operation

PHOTO, COURTESY WATSON MACHINE CO.

2. Some less desirable physical properties.
3. Slight distortion or warpage at the extreme flange edges. This fault, however, can be minimized by an increase in sheave spacing in multiple mount, or can be corrected by a facing operation as the material is easily machineable.

By and large, however, the advantages of the plastic material are thought to outweigh the less desirable features by a comfortable margin, particularly as improvements are likely to be made in the redesigned product.

Credits—Material: Bakelite. Molded by Mack Molding Co., Inc., for Watson Machine Co.

Aircraft windshields

(***Continued from page 107***) hr. at test windshield panels. Looking like an anti-aircraft gun, the fowl shooter has an eight-inch bore and a twenty-foot barrel. Freshly killed bird carcasses are weighed, placed in flour sacks, stuffed into the barrel and shot at speeds simulating actual flight conditions. Approximately 100 panels now have been tested by the Civil Aeronautics Administration in this program. Most of them have included a double-glazed type construction with an intermediate air space through which hot air may be circulated for de-icing purposes.

A variety of types of windshield construction have been included in the tests, varying from heavy laminated tempered glass panels to essentially all-plastic types. The method of edge mounting in the windshield frame also has been varied, and has included both a rigid clamped mounting and a bolted type mounting wherein the bolts are passed through plastic edges on the windshield panel. Tests also have been carried out at various temperatures between 20° C. and 60° C. and at various angles of impact.

The tests have indicated that to obtain the greatest impact strength with the least weight it is advantageous to incorporate a maximum amount of relatively soft plastic of high toughness in the panel, and a minimum amount of hard plastic or glass. The type of panel construction which has proved most resistant to impact, and in which de-icing means is included, consists of a double-pane arrangement with a $^1/_4$-in. sheet of fully tempered glass for the front pane, a $^1/_4$-in. air space for circulation of hot air and a laminated rear pane consisting of two sheets of $^1/_8$-in. semi-tempered glass with a vinyl plastic interlayer of from $^1/_8$-in. to $^3/_8$-in. thickness. The plastic interlayer is extended beyond the edges of the glass on all sides to form a resilient plastic mounting through which the bolts may be passed. It has been found that panels of this type with a $^3/_8$-in. plastic thickness will resist the impact of a 4-lb. bird carcass at velocities greatly exceeding 300 mi. per hr., and will resist the impact of a 16-lb. carcass at a velocity exceeding 200 miles per hour.

The polyvinyl butyral interlayer used in the laminated rear panel has proved capable of absorbing large amounts of impact energy, in this case approximately 22,000 ft.-lb. being absorbed in a 12-in. by 36-in. panel. As is well known, however, the elastic properties of this material are influenced strongly by temperature, with the maximum impact resistance being obtained at the temperature where an optimum combination of tensile strength and degree of elongation are produced. With a 20 percent plasticizer content of the vinyl interlayer, this optimum strength is reached at about 40° C., which approximately is the average temperature in the plastic with warm air being circulated for de-icing. The impact resistance of this material still is high as the temperature is decreased to 25° C., but drops off rapidly at lower temperatures. It now is anticipated that in actual practice the warm air used for de-icing purposes will be circulated through the windshield under all conditions of low outside temperature, even when no ice formation is threatened, in order to maintain adequate impact characteristics of the plastic.

The extended vinyl plastic edges of the windshield through which the mounting bolts are passed have been found to have a tendency to

shear under the impact load. This, however, may be overcome readily by incorporating an aluminum strip in the plastic along the edges where the bolts are placed.

In addition to the laminated glass-vinyl type windshield panels, cellulose acetate sheets up to $^{1}/_{8}$-in. thickness, and laminations including methyl methacrylate sheets with thick vinyl interlayers have also been tested. While as yet none of these combinations has shown an impact strength as great as that of the laminated glass-vinyl type construction, considerable promise has been indicated for these materials, and further development may result in satisfactory windshield panels in which they are utilized. In particular, it has been found that the use of a hard, high-scratch-resistant plastic, such as methyl methacrylate, in place of glass on the surfaces of the rear laminated pane results in the retention of greater vision after the impact, and eliminates the danger of sharp glass splinters flying off the rear face of the windshield.

The problem of obtaining satisfactory optical characteristics of heavy laminated glass and plastic windshields is a difficult but important one from the practical standpoint. It now appears possible to reduce distortion to a reasonable limit in any of the types of construction which have been considered. The laminated panels utilizing glass surfaces, however, probably have an advantage in this respect.

The problem of obtaining absorption of ultraviolet and infrared radiation is a relatively new one with the advent of high altitude flying. The vinyl interlayer in the windshield in the thicknesses used normally is highly absorbent in these regions of the spectrum, and cellulose acetate can be made similarly so. If further reduction of transmission of these wave lengths is required, it may be obtained readily through the use of selectively absorbent glass, without serious change in the visible region.

New war planes

(Continued from page 69) shrinkage. Ordinarily an odd number of layers is put into place so that the grains of the first and final layers are running parallel.

After the layers of veneer are in place, a rubber bag or blanket is put over the entire mold and a vacuum created. The mold is then put into an autoclave, and the temperature raised to about 300° F. and the pressure to 80–100 p.s.i. Since some surfaces are 125 sq. ft. in area, the total force exerted on the load is over 875 tons. The section is cured for twenty minutes. This heating and curing cycle causes the resin to flow from the impregnated phenolic paper and penetrate the layers of veneer, causing them to adhere together after curing, with the phenolic resin from the paper acting as an adhesive.

The frames and stringers are then placed in the fuselage assembly jig and properly aligned. The finished fuselage shells are then glued to the frames and stringers while they are in the jig. The two lateral halves of the fuselage shell are spliced at the center line, and the fore and aft section of the fuselage are bolted together after the removal from the assembly jig.

At this point the wing sections are put on the plane. They are formed by gluing skins of preformed plywood over the wooden spar and rib structure. This skin is also fastened to the framework with a cold set urea.

After the wings have been set on the fuselage, the gun turrets, tail assemblies and nose are placed on the plane. Turrets and nose are made of aircraft grade transparent plastic. Throughout the plane the insulation on the wiring is also a plastic.

The plane is powered by two twelve-cylinder double bank, inverted V in-line Fairchild Ranger engines.

Bristol Beaufort

When in September 1939 Australia found herself involved in a war, the aircraft industry was in its infancy. The manufacture of automobile engines was almost non-existent, let alone airplane engines.

Shortly before this catastrophe, however, the Commonwealth Government in consultation with the British Air Ministry had de-

cided upon the assembly in Australia of a twin-engined Beaufort torpedo bomber, the best British plane of its class and still one of the best in the world. The engines and those parts requiring high technical skill in the making were to be imported from Great Britain. The remainder of the job was to be handled at home.

Following the collapse of France in June 1940, and the withdrawal of the British Army from Europe, Australia's war production plans were completely dislocated. She was left with the formidable problem of manufacturing practically all the necessary parts and components of the plane, and this from scratch.

A number of twin-row Pratt & Whitney Wasp engines, each 1250 h.p. (uncompleted French orders) were obtained from America. The Beaufort Division of the Aircraft Production organization undertook the extensive modifications essential for their installation. They set up a heavy forging annex for the production of propeller blades, built a plant for the production of oleo legs, developed facilities for manufacturing aircraft instruments and succeeded in the local manufacture of Pratt & Whitney twin motor engines.

While this work went forward, Beaufort assembly plants were being established, and in cooperation with Government workshops sub-assembly plants were established for the fabrication of major components such as fuselages, wings, etc. Some 330 private contractors were also invoked in the production of the 39,000 separate parts required to complete each Beaufort torpedo bomber.

Today Australia has a comparatively large-scale aircraft production. The Beauforts, used for both long-range reconnaissance and as bomb and torpedo carrying units, are taking an effective part in her defense.

All external windows on the Beaufort, together with the tops of the gun turrets, are fabricated from methyl methacrylate. As there is necessarily considerable stress under certain conditions, these windows are attached by means of duralumin strips, bolted through the structure of the aircraft.

A rudder trimming tab constructed of Australian timber veneers, shaped and bonded in an autoclave, and employing cresol resins as a bonding agent is now in the experimental stage. The resin used is manufactured in Australia. If this method is successful it will be of major importance from the point of view of aircraft weight.

Leading edge doors on the wings, numerous inspection doors, bomb and torpedo chamber doors (Australian timbers have supplanted the English timbers originally specified for these), in addition to the fin of the aircraft, are also in line for application of this method. The use of plastics in the manufacture of these parts, once the necessary dies and forms are available, will be cheaper and quicker.

Pulleys, and in certain cases sprockets, are molded of fabric-filled phenolic laminates, which reduces the demand made on duralumin as well as on manpower and machine tools. Conduit and pipe clamps are likewise molded of laminated phenolic material. Packings and certain parts which were formerly made of duralumin extrusions have been redesigned in order to use plastic materials of this same type. Guides and cable fairings are fabricated from laminated sheets, and investigation is now under way with a view to molding as many of these parts as practicable. The bulk of Australia's phenolics are supplied by local manufacturers, the remainder coming from abroad.

Canada's plastics industry

(*Continued from page 77*) by research men for use in shoe soles. Also new is the big Dow plant at Sarnia, Ont., where styrene monomer will be made for use in synthetic rubber.

This, then, is Canada's plastics industry. Compact, prevented by our control of chemicals and machines from being chiselled into by "wildcats," built around a framework of a few solid companies with years of experience in molding, yet now expanded in production beyond any dreams of three years ago, enjoying already the fruits of technical cooperation forced by war contracts, supported and assisted by the National Research Council and several universities and now organized as a chapter of S.P.I., it is as solid a business as can be found anywhere and is doing a terrific job to help win this war in a hurry.

News

(Continued from page 130)

★CIVILIANS, ATTENTION. THE ARMY WANTS *YOUR* IDEAS. Soldiers' and sailors', too. Send them to: The Engineer School, Fort Belvoir, Va. Construction, materials, safety, transportation, etc. . . . no useful idea is too small to report. Suggestions are submitted to the critics without indication of their source. Each suggestion is selected in the American way—solely on its own merits.

★ COMMERCIAL PRODUCTION OF CHEMURGIC RUBBER based on domestic drying oils ordinarily not considered suitable for edible purposes, has been underway at the Chicago plant of The Sherwin-Williams Co. for several months, according to Dr. N. E. Van Stone, vice-president in charge of operations. Called "KemPol," the new material is an original development of the company's research laboratory's basic research work with oils.

Tensile strength, elongation and abrasion resistance of KemPol are not equal to those of natural rubber, although in many other properties it is said to compare so favorably with rubber as to enable its use in many products. Molded and extruded products such as treads, mats, pads, erasers, jar rings, food and other closures (no toxic raw materials), gaskets, braided hose and many other similar products may be made from the material. It is said to lend itself readily to emulsification, and with certain limitations, to solutions, so that a number of successful commercial applications in the fields of fabric coating, tapes, adhesives, sealing compounds, etc., have resulted. It sponges readily, offering many possibilities in that field.

The material also is reported to show considerable promise as an extender for natural, reclaimed and the buna and butyl rubbers, with all of which it is readily compatible. A complete report of the development will appear in an early issue of MODERN PLASTICS.

★ THE UNEQUALLED PER CAPITA WAR OUTPUT OF GREAT Britain, as disclosed in a study on war production controls of non-essential industries by the Division of Industrial Economics of The National Industrial Conference Board, 247 Park Ave., New York City, has been due to a three-fold program of concentration. The initial step controlled raw materials by restrictions and quota limitations set on sales to retailers. This plan was supplemented in March 1941, by a policy designating a few factories as nucleus firms to take over the quotas of closed-out firms and produce the total amount allowed. At the present time production is limited to standard fixed-price "utility" goods which are closely calculated to satisfy essential civilian needs.

At the beginning of the war the program released approximately one million insured workers in thirty consumers' goods industries, and up to July 1942, almost an equal number have been released. Some 55 million sq. ft. of factory space has been made available. The British program is under close study by U. S. officials who feel that the methods employed and results achieved are deserving of careful consideration.

★ A GLUE AND GLYCERIN COMPOSITION IS BEING OFFERED to the plastic trade as a replacement for rubber molds. Called Star No. 8 Composition, this material is offered only for high priority work by Bingham Bros. Co., 406 Pearl St., New York. Material, which is packed in cakes, must be melted down in a double boiler. It is claimed to have a minimum of moisture and to bring out all of the undercuts and fine details in the molds. It is reported the molds will not shrink.

★ A NEW SOUND MOTION PICTURE, "DRIVE FOR VICTORY," endorsed by Rubber Administrator William M. Jeffers, and with a cast of professional actors, is being distributed by the Goodyear Tire & Rubber Co., Akron, Ohio. Problems of synthetic rubber with facts on its production possibilities, tire conservation and rubber sources are among the subjects covered.

★ MORE THAN 40,000 EMPLOYABLE JAPANESE-AMERICANS evacuated from West Coast military areas by Executive Order are now available to war industries according to an announcement by the Committee on Resettlement of Japanese Americans, 297 Fourth Avenue, New York City. Their available skills range from laborers to machinists, engineers and lawyers. The Committee emphasizes that the War Relocation Authority and the Federal Bureau of Investigation will investigate all evacuees to be employed by private industry and only those whose loyalty is proved will be permitted to come out. Further details can be obtained from the Committee on Resettlement.

Publications

(Continued from page 120)

★ INVINCIBLE TOOL COMPANY, FORT WAYNE, IND., ISSUE A booklet illustrating their angle tool attachments and giving applications to which the tools are suited. Address Mfg. Shop Office, 611 Empire Bldg., Pittsburgh, Pa.

★ MINE SAFETY APPLIANCES CO., PITTSBURGH, PA., HAS published a descriptive brochure on Fend products for protection against industrial dermatitis. Included is an application chart of the lotion or cream to be used against specific chemicals and processes.

★ THE LAST QUARTERLY ISSUE OF *BALDWIN SOUTHWARK* includes interesting articles on industrial developments in which the products of Baldwin Southwark, Div. of the Baldwin Locomotive Works, Philadelphia, Pa., play a part. Dramatic pictures show the "machine behind the machine"—hydraulic machinery, test machines and instruments.

★ "THE DI-ACRO SYSTEM OF METAL DUPLICATING WITHOUT Dies" is a revised and up-to-date catalog, 32 pages, published by O'Neil-Irwin Mfg. Co., Minneapolis, Minn. It gives a thorough coverage of Di-Acro precision machines with descriptions, specifications and illustrations.

★ A COMPLETE PRINTED REPORT OF THE PROCEEDINGS OF the war service meeting of the Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41st St., New York City, held at the headquarters of Electrical Testing Laboratories, Inc., December 7, may be obtained from the Association.

★ DESCRIPTIONS AND SPECIFICATIONS OF TWO NEW PATented process steels developed by W. J. Holliday & Co., Indianapolis, Ind., are contained in their bulletin No. 942. "Speed Case" and "Speed Treat," the two products concerned, are, respectively, a low and medium carbon open hearth case carburizing steel.

★ "EVALUATION OF DYE INTENSITY," BY F. O. SUNDSTROM, a comprehensive study of the testing of dyes for better application in the manufacture of paper, has been reprinted from *Paper Industry and Paper World* in Calco Bulletin No. 672. While directed specifically to the paper trade, the article contains many valuable points on the use of dyestuffs which will be of interest to others. Obtainable from Advt. Dept., Calco Chemical Div., American Cyanamid Co., Bound Brook, N. J.

★ NATIONAL BOARD OF FIRE UNDERWRITERS, 85 JOHN ST., New York, has issued a useful little pamphlet, No. 43, which is devoted to a discussion of the storage and handling of pyroxylin plastics in warehouses and wholesale jobbing and retail stores, based on recommendations from the National Fire Protection Association.

★ A 50-PAGE CATALOG, NO. 42, ON COUNTING, TIMING AND recording devices has recently been made available from the Production Instrument Co., W. Jackson Blvd., Chicago, Ill. Illustrated and described are developments in mechanical and electrical counters, recently developed predetermined electric counters and high speed coil winding counters, as well as other mechanisms available from this company.

★ ROBINSON MFG. CO., MUNCY, PENNA., HAS PREPARED A 27-page Catalog No. 27-A which clearly illustrates and describes the variety of brush sifters available from this company.

★ BULLETIN NO. 300 ISSUED BY THE ROBINSON MANUFACturing Co., 30 Church St., New York City, briefly describes the latest developments and additions to their "Unique" line of mixers, sifters, cutters, crushers, grinders, attrition mills, hammer mills, pulverizers and rubber reclaiming equipment.

★ A NEW, MODERN DISPLAY CABINET, KNOWN AS THE M.S.A. Toll-Board, is described in detail in bulletin CD-10 issued by the manufacturer, Mine Safety Appliances Company, Pittsburgh, Pa. Constructed of non-critical materials and illuminated, the unit is designed for wartime posters and bulletins and permits easy change of material.

Classified Advertisements

All classified advertisements payable in advance of publication. Rates: $5.00 up to sixty words; enclosed in border, $10.00 per inch. Publisher reserves the right to accept, reject or censor all classified copy.

WANTED: THERMOPLASTIC SCRAP or rejects in any form, including Acetate, Butyrate, Styrene, Acrylic and Vinyl Resin materials. Submit samples and details of quantities, grades and color for our quotation—Reply Box 508, Modern Plastics.

WANTED: PLASTIC SCRAP OR REJECTS in any form, Cellulose Acetate, Butyrate, Polystyrene, Acrylic, Vinyl Resin, etc. Also wanted surplus lots of phenolic and urea molding materials. Custom grinding and magnetizing. Reply Box 318, Modern Plastics.

FOR SALE: Motor Driven Air Compressor, Size 12 x 10, 260 cu. ft. displacement, 100 lbs. pressure. Reply Box 512, Modern Plastics.

FOR SALE: 400 Ton Horizontal Hydraulic Extrusion Press. Hydraulic Scrap Baler, 80 Ton. Werner & Pfleiderer Jacketed Mixers, Laboratory size and 150 gallon. Large stock of Hydraulic Presses, pumps and accumulators, preform machines, rotary cutters, mixers, grinders, pulverizers, tumbling barrels, gas boiler, etc. Send for bulletins #138 and L-19. We also buy your surplus machinery for cash. Stein Equipment Co., 426 Broome St., New York City.

WANTED: CHEMIST OR CHEMICAL ENGINEER. Large New England manufacturer seeks man with several years experience in the use of synthetic resins. Should have knowledge of laminating and molding with high and low pressure types and the modification of resins to meet specification requirements. Reply Box 714, Modern Plastics.

FOR SALE: 1—Triplex Hydraulic Pump 2.85 g.p.m. at 3500# pressure; 1—Hydro-Accumulator 2500 PSI, 16½ gals., complete with tank, compressor and piping; 1—W. S. 15" x 18" Hydraulic Press, 10" dia. ram; 2—D. & B. 20½" x 20½" platens; 1—14" x 24" Press, 9" ram; 9—24" x 55" Steel Cored Heating Platens; 1—Stokes "N" Pilling Machine; 1—Farrel Birmingham 15" x 36" Rubber Mill; 4—W. P. Mixers; 1—Set of Compound Rolls 15" x 36"; Adamson 6" Tuber; Dry Mixers; Pulverizers, Grinders, etc. Send for complete List. Reply Box 446, Modern Plastics.

WANTED: Hydraulic Presses, Preform Machine and Mixer. Stainless Steel or Nickel Kettles, Vacuum Pan. No dealers. Reply Box 275, Modern Plastics.

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FOR SALE: 6, 7, 8, and 10" Rubber Extruders. 1—36" Bonnot Pulverizer. 1—000 Abbe Mill. Reply Box 709, Modern Plastics.

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WANTED: Full lines or specialties in plastics for any class of trade by an old established and well financed firm of manufacturer's agents to sell on a commission basis or outright purchases for Pacific Coast territory. Reply Box 713, Modern Plastics.

FOR SALE: Three C. & Y. flock cutters, rebuilt like new, all knives brand new, price $500.00 each. These cutters especially designed for making cotton flocks for plastic compounding. Reply Box 715, Modern Plastics.

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HELP WANTED: Aggressive manufacturing firm near Chicago loop needs man or woman for plastic coatings laboratory research work. Must have sound knowledge of plastic materials, uses and application. Permanent. Write fully giving education, experience, age, draft status and salary desired. Reply Box 711, Modern Plastics.

WANTED: Injection molding machines 8-oz. and larger. Give full details regarding make, age, serial number, and condition. Reply Box 712, Modern Plastics.

WANTED IMMEDIATELY purchase or rent, Extruders, National or Royle 2½" or larger. State age, condition and price. R. D. Werner Co., Inc., 380 Second Ave., New York, N. Y.

WANTED: Bakelite Pre-forming Press. At least 2½" Diameter Pre-forms. Preferably Stokes. Reply Box 723, Modern Plastics.

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Modern Plastics

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HEATRONIC

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